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ABSTRACT

Cost behavior analysis, a costing process that can assist managers in estimating how certain institutional costs change in response to volume, policy, and environmental factors, is described. The five steps of this approach are examined, and the application of cost behavior analysis at four college-level settings is documented. The institutions and areas of analysis are as follows: Denison University-operation and maintenance (O&M) of physical plant: Drake University-instructional capacity: Santa Fe Community College-student services: and the University of Wisconsin System--library services. A major feature of the Denison study is the method used to assign O&M service levels to particular kinds of rooms. In the Drake study, a formula was developed that shows classroom utilization as an important feature of the study. The Santa Fe study is useful for its validation of the requirements of different kinds of students for varying levels of student services. The library study undertaken at the Wisconsin System was a component of a much larger effort to develop a formula to appropriate state revenues. The method used for dividing library services into those that are affected by student enrollments and those that are affected primarily by acquisitions is also significant. It is suggested that the case studies reveal the challenge of applying cost behavior analysis to the internal reallocation of resources and to state allocation of funds. (SW)

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costing for policy analysis

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foreword

Since the early 1970s, the NACUBO and NCHEMS boards of directors, volunteer committees, and professional staffs have devoted much of their resources and talents to improving the cost information used by colleges and universities. Both organizations have achieved significant accomplishments in the field. The material in this document contributes to the improvement of cost information for decision making.

This report describes a costing process that can assist managers in estimating how certain institutional costs change in response to volume, policy, and environmental factors. The concept is called cost behavior analysis and was advanced by Robinson, Turk, and Ray in a paper commissioned by NACUBO's Costing Standards Committee in 1975. In 1978, the cost behavior analysis process was developed into a five-step guide and used in four institutional settings.

The results of these four case studies can enable managers and analysts to better understand the process of determining the relationship of cost functions to various factors at their institutions. The case studies revealed the challenge of applying cost behavior analysis to the internal reallocation of resources and to state allocation of funds. Each of the case studies determined that factors other than volume (for example, service level or type of square footage) affected costs. The cost methodologies that were developed identified such factors and measured their impact on costs. More documentation on the use of cost behavior analysis is required, particularly in the allocation of state resources. NACUBO and NCHEMS are committed to pursuing this goal.

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The steering committee that supervised and counseled the staff and institutional researchers was a subcommittee of NACUBO's Financial Management Committee. The experience and participation of committee members were crucial to the success of the project. The committee worked for 18 months reviewing designs, drafts, and comments, and then made recommendations for revisions. Members of the committee were:

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Frederick J. Turk of Peat, Marwick, Mitchell & Co. provided assistance in the initial project design and offered guidance to the researchers conducting the Wisconsin System case study. George W. Baughman of The Ohio State University was instrumental in developing Denison University's study of operation and maintenance costs. Baughman was also a consultant to the Santa Fe case study of student services. Nathan Dickmeyer of the Economics and Finance Unit of the American Council on Education was responsible for the Santa Fe case study computer model and also assisted staff in preparing report drafts.

Research was completed by institutional managers based on cost behavior analysis. Those responsible for directing the work and effort of the case studies were:

Denison University
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Robin Jenkins of the NACUBO staff coordinated the project and drafted Chapters 1, 2, and 3 of the final text under the supervision of the codirectors of the projects, K. Scott Hughes of NACUBO and James R. Topping of NCHEMS. Mark Chisholm of NCHEMS directed the research at Drake University and Richard Allen of NCHEMS assisted in the review process. James A. Hyatt of the NACUBO staff assisted in the many revisions of the draft report.

NACUBO requested 25 professionals to review the draft of the final report; their comments and suggestions offered valuable insights.

one • background & purpose of the study

NACUBO and NCHEMS, both cooperatively and independently, have assisted college and university business officers in conducting costing studies since the early 1970s. Much of NACUBO's early interests in costing stemmed from its work for indirect cost reimbursement. NCHEMS' early involvement resulted in the development of a comprehensive costing system that focused on calculating the average cost of instruction for colleges and universities of varying sizes and control. This research was later incorporated into NCHEMS' Information Exchange Procedures and was published jointly with NACUBO as *Procedures for Determining Historical Full Costs: The Costing Component of NCHEMS Information Exchange Procedures.*

Over the last few years, college and university managers have been asked to provide more cost information for use in making internal management decisions. Cost information that is produced for decision making should indicate how changes in enrollment levels, government regulation, and energy prices affect an institution's program resources. Costing techniques that generate this kind of information (fixed, variable, semivariable, and marginal costing) have been used widely in the business community but have had only limited application in colleges and universities.

NACUBO and NCHEMS began with these industrial techniques as a starting point for this project. Together with a group of college and university managers, the NACUBO and NCHEMS staffs attempted to develop a methodology for marginal costing in higher education. The more the committee tried to apply industrial techniques to educational functions, the more they realized the inadequacy of those techniques that related changes in costs primarily to changes in volume. Colleges and universities have products, or units of production, only insofar as a student is educated and graduated from an institution. Even ancillary services (such as food service and bookstores) are not entirely adaptable to marginal costing because they are so closely tied to policies that affect instruction. Policies are important factors in determining faculty salaries, student services, financial aid, and program costs. Policies are shaped by many factors; some are institutionally controlled and others are controlled by some

element in the environment. For example, institutional mission, recruitment, academic goals, and administrative techniques are all controllable factors, while enrollment trends, energy costs, government regulations, and accreditation requirements are all uncontrollable factors.

No single costing technique was sufficiently comprehensive to monitor the effects that volume, policy, and environmental factors have on an institution's costs. Therefore, the NACUBO/NCHEMS steering committee designed a costing process—cost behavior analysis—to assist managers in producing needed cost information by combining appropriate costing techniques and administrative judgments. The theoretical basis of cost behavior analysis evolved from two articles published by NACUBO's Costing Standards Committee (now the Financial Management Committee). *Fundamental Considerations for Determining Cost Information in Higher Education* (October 1975) reviewed the basic tenets of industrial costing and attempted to build the conceptual bridges that would be necessary before costing could be applied generally to higher education. It includes a set of twelve standards on which to base costing. These standards serve as the foundation for the costing process presented in this study. The second article, *Cost Behavior Analysis for Planning in Higher Education* (May 1977) prepared by Peat, Marwick, Mitchell & Co., describes the conceptual framework for performing the cost behavior analysis described in this report.

This report uses those earlier studies as the basis for applying cost behavior analysis to higher education. More specifically, the study has two purposes:

1. To develop a costing guide, "cost behavior analysis," that can assist managers and policy analysts in determining how and when to employ costing techniques, how to obtain the necessary data for the analysis, and how to make the most effective presentation of cost information for decision making.

2. To provide insights and suggestions from administrators and analysts who have undertaken cost studies in particular program areas.

To utilize the concepts of cost behavior analysis, the steering committee first developed a general approach consisting of five separate steps (see Chapter 3). Managers at four campuses representing public and independent, small and large, and systemwide and individual institutions applied those five steps to four different functional areas: physical plant, instruction, student services, and libraries (see Chapters 4 through 7). These case studies discuss specific events leading to the study, actual study design, analysis of the data, and implications for future policy at four institutions; however, many of the techniques employed in the cost studies could be used in other institutional settings.

two • cost behavior analysis

Using Cost Information for Policy Analysis

Colleges and universities are affected by shifts in the economy, demographic trends, energy needs, government regulations, employee demands, the demand for particular academic programs, and internal policies and operating procedures. To measure the impact of such factors on the costs of the educational process, it is necessary to determine the changes in costs of those functions. Managers often perceive that changes in costs are caused by changes in environmental factors or internal operating procedures, but do not fully understand the cause-and-effect relationship between those factors and costs. As a result, much cost information by which institutional policies are analyzed may be incomplete or inappropriate.

If cost information is to be useful in such analysis, managers must understand the relationship between changes in costs and changes in factors that affect costs—volume, policy, and environment. With this understanding, managers should be able to estimate cost changes that may occur because of changes in an environmental factor or an internal operating procedure. Policies and procedures can then be altered to modify the impact on cost of other factors.

What Is Cost Behavior Analysis?

This report documents a costing process—cost behavior analysis—that (1) helps managers estimate the cause-and-effect relationship between environmental factors or internal operating procedures and institutional costs, and (2) aids in analyzing potential policy alternatives. If cost behavior analysis is to be successful, the purpose of the information derived from the cost study must be clearly stated. With this knowledge, managers can develop a methodology that identifies the functions requiring analysis and examines the appropriate costs to be studied.

Cost behavior analysis can be more completely described by defining each of its terms. In this report, "cost" refers to resources committed to or expended for specific functions and departmental objectives. A specific definition of "cost" depends on the particular purpose for which the cost information is to be used. "Behavior" refers to the dynamic characteristics of costs as they

change because of changes in volume, policy, and environment. "Analysis" is the development of cost information for specific management applications.

The three factors that affect costs—volume, policy, and environment—must be accurately identified to be a useful part of the analysis. Such identification depends on the experience and administrative judgment of the analysts and managers undertaking the study.

Volume factors relate to the behavior of cost as it reacts to changes in volume within a defined range of activities or services for a given period of time. Measures of volume are based on their applicability to the functions being costed. Enrollment—headcount or full-time equivalent (FTE)—is the primary measure of volume, but the number of library holdings circulated, FTE faculty, or assignable square feet may be more appropriate for certain cost functions. Volume factors are partially controllable by institutional managers. For example, in the analysis of the volume factor "enrollment," demographic trends (an environmental factor) are uncontrollable, but recruiting policies (an internal factor) are largely controllable.

Policy or decision factors are specific institutional attributes or elements of goals, objectives, and programs, the organizational structure, and operating policies that can be directly and substantially affected by administrators' decisions. The higher one's position in the organizational structure, the more impact one can have on the determination of policy and, ultimately, on cost behavior. At the president's level, most policy variables are considered controllable factors, while many policy variables are largely beyond the program director's control. For this reason, it is important at the outset of the study to designate the management level for which the cost study is being conducted.

Environmental factors are social, economic, political, cultural, and physical conditions over which institutional managers have no substantial or direct control. Environmental factors include the overall economic situation, shifts in population, state and federal legislation, and geographic location. Because environmental factors cannot be changed, the institution must plan its policies and procedures within these limits to survive. Changes in environmental factors often cannot be predicted with certainty, but educated guesses about likely trends are important to the planning process and hence to the analysis of cost behavior.

How Cost Behavior Analysis Relates to Costing Techniques

Cost behavior analysis employs one or more of five basic costing techniques—historical cost, projected cost, standard cost, replacement cost, and imputed cost—depending on the intended use of the cost information.

Historical cost is usually expressed in terms of the monetary value of economic resources released to pay faculty and staff salaries, to acquire materials and services, and to use facilities. Historical cost can be calculated from data on expenditures. For example, past performance may be evaluated by tracking expenditure patterns for a certain number of years.

Projected cost, for an educational institution, is an estimate of the cost to be incurred in a future period. Changes anticipated in programs, enrollments, faculty mix, faculty workload, support required, salary rates, and economic conditions all affect cost expectations.

Projected cost is based on available knowledge about past activities, expectations about the effect of new activities, and changing conditions of cost. Projected costs are often used to examine various policy alternatives.

Standard cost is a predetermined cost used as a target or basis of comparison with actual cost when units of service are provided. Establishing a standard cost involves examining past occurrences in detail and evaluating expectations to arrive at meaningful standards of performance. Standard costs may be based on historical experience or on special studies. They are often used in the state appropriations process, which requires an understanding of costs for similar functions in institutions across the state.

Replacement cost refers to the present or future cost of constructing, acquiring, or purchasing facilities, services, or materials that are similar to existing ones. Replacement costs are often used to measure the effects of inflation or to compare original costs with present or future costs.

Imputed cost relates to resources that would have been available to an institution but are not because one alternative was chosen over another. Imputed cost does not consider the past, present, or future disbursement of cash or its equivalent; rather, it measures the cost of alternative opportunities. An example of imputed cost is the revenue lost by failing to fill most class sections to capacity.

For cost analysis purposes, components of cost may be classified as direct or indirect. Direct costs are those expenses that are readily identifiable with an activity or unit; conversely, indirect costs are those costs not readily identifiable with an activity or unit.

Four factors determine whether costs are developed as direct or indirect in cost behavior analysis. The first consideration is the level of aggregation of an activity or unit being costed. For example, a portion of the compensation paid to a department head may be considered an indirect cost to each course in that department. However, if the unit being costed is the department as a whole rather than individual courses, the compensation paid to the department head is direct. The second factor is the practicability of assigning costs directly to the activity or unit to achieve greater precision. The tradeoff in this decision is the expense of generating indirect cost data versus the precision of estimating the total cost. In situations such as the development of cost information for reimbursement, generating more expensive cost information may be worthwhile. The third factor to be considered is the judgment that managers must exercise in classifying costs, and the fourth factor relates to the differences among institutions, such as organizational structure and operating policies.

Components of cost also may be classified as fixed, variable, marginal, or semivariable (mixed). Fixed costs remain constant over the short run. Some costs are classified as fixed because of an institution's policy decisions; they may be referred to as "discretionary." Other fixed costs cannot be altered by policy changes; they are "nondiscretionary." For example, a discretionary fixed cost could be the reduced tuition level for a set number of students established by admissions policy; a nondiscretionary fixed cost could be the existing contractual arrangements with faculty and staff. Identifying the discretionary and nondiscretionary fixed costs of an activity is useful in cost behavior analysis because it reveals the impact of policy decisions on costs.

Variable costs fluctuate in proportion to a volume factor. Identifying the variable component in cost behavior analysis is important because this component establishes the relationship between a change in volume factor and a change in the cost of an activity. An example is the variability in the cost of instruction when enrollment changes. Marginal cost, which is similar to variable cost, is the increase in total cost attributable to one more unit of production or service. While *variable* cost measures the variable portion of total cost for a particular volume level, *marginal* cost measures the rate of change of the total cost function.

Semivariable costs include both fixed and variable elements, with the fixed portion relating to minimum service levels and the variable portion depending on use. Semivariable costs react to volume changes irregularly; thus, cost that is fixed for a certain range of units of service becomes variable as that range is exceeded. For example, semivariable costs are useful in determining the costs of a multisection course in which participation in a given course requires more than one section because of a limit to class size.

three • the five steps of cost behavior analysis

The five steps that make up cost behavior analysis are designed for adaptation to most studies that examine the cause-and-effect relationship between costs and volume, policy, or environmental factors. Following are the five steps:

1. Determine policy questions and identify the management level served by the study.
2. For each function under study, identify the activities, activity measures, and factors that affect costs.
3. Determine current levels of service for each activity and assign costs to each activity.
4. Determine the behavior of costs for each activity.
5. Evaluate and document the policy implications of the study.

This chapter defines each step and describes the way in which it was used in the case studies.

Step 1. Determine Policy Questions and Identify the Management Level Served by the Study

The purpose of a cost study must be well defined and directly related to the pertinent policy questions under study, and the management level using the information that results from the cost study must be clearly identified. For example, a study undertaken for the governing board will differ significantly in scope and purpose from one performed for a line manager within the institution. Careful implementation of Step 1 will make the selection of appropriate definitions and costing techniques in Steps 2 and 3 more obvious.

Denison University (Denison). The vice president for finance and management posed the policy question: "How can resources be conserved in routine operation and maintenance of the physical plant?" Cost information about specific buildings, types of rooms, and kinds and volume of services performed is important in selecting policy alternatives intended to conserve resources. A study

generating this kind of cost information was needed because conventional cost accounting systems did not recognize cost variations caused by the type of service and the character and use of space served.

Drake University (Drake). The vice president for academic affairs and the director of administrative systems posed the policy question: "How can instructional resources be better utilized?" It was determined that a special study identifying capacity and utilization of the instruction function could be useful to academic deans for planning purposes. Because 80% of Drake's courses have only a single section, instructional costs are influenced by the number of academic programs as well as by enrollments. A study on capacity and utilization was thought to be more useful than traditional fixed and variable costing because so much of instructional cost depends on curriculum. Fixed and variable costing would indicate that most of Drake's instructional costs are fixed, as changes in enrollment have little effect on the costs of instruction. Fixed and variable cost information is useful in defending current budget expenditures, but it does not assist managers in identifying places where costs can be cut. Using capacity as a surrogate for costs is a nontypical approach, but it is understandable when considering lost revenue from empty spaces in the classroom.

Santa Fe Community College (Santa Fe). The vice president of the college posed the policy question: "How do changes in the enrollment levels of different academic programs affect the cost of student services?" Typical cost analysis would indicate only the average cost incurred per student, not the differences in accommodating credit and noncredit students. Therefore, a cost study was undertaken to test the assumption that credit professional program students require more student services than noncredit community program students. Results of this study could assist the vice president in projecting the budget for student services, once the number of students in a particular program area was known. (The results of the study indicated that need for student services varied by type of service and by type of student program).

University System of Wisconsin (Wisconsin System). The state governor posed the policy question: "How can the funding formula for libraries be revised to more accurately reflect the appropriate mix of fixed and variable costs?" It was felt that the state's existing formula did not fully reflect the fixed costs of maintaining an institutional library; thus, a special study was undertaken to assess the resource needs for libraries. This study identified the range and level of academic programs served by the different libraries in the system and determined the effects of changing enrollments on library costs. Plans are to include the outcome of the library study in the System's presentation to the board of regents and to the state legislature with recommendations for modifying the funding formula.

Step 2. For Each Function Under Study, Identify the Activities, Activity Measures, and Factors that Affect Costs

The manager or analyst undertaking the study should identify and describe (1) the function to be studied, (2) the various activities contained within a function, (3) the activity measures that quantify the activities, and (4) the volume, policy, and environmental factors that affect the costs of the activities.

A **function** is any organizational unit, program, or specific service to which costs may be assigned.

An **activity** is a discrete component of the function. For any given function, a manager selects for study those activities pertinent to the policy question.

An **activity measure** is a unit (FTE students, square feet, library holdings, student credit hours, etc.) that measures change in the volume of an activity. An activity measure is used to relate changes in activity level to changes in costs.

A **factor** is an element that affects costs; it can be a volume, policy, or environmental factor. The administrative judgment and experience of the manager undertaking the study allow that manager to determine significant factors that affect costs. The manager should distinguish between controllable and uncontrollable factors.

Table 1 shows the functions, activities, activity measures, and factors affecting the costs for each of the four institutions where cost behavior analysis was performed for this study.

Table 1

	Functions	Activities	Activity Measures
Denison	Operation & maintenance of the physical plant	Cleaning Heating Electricity Water & sewerage Maintenance	Square feet Pounds of steam Kilowatts Gallons Square feet
Drake	Instruction	Departments, majors, courses	Utilization of capacity
Santa Fe	Student services	Counseling & advisement, financial aid administration, records & admissions	Fall headcount (full-time & part-time students)
Wisconsin System	Library services	Technical services Information services	No. of holdings FTE students

Some Factors Affecting Costs

	Factor	Type	Control
Denison	Level & type of service (5 days/week, 65 degrees)	Policy	Controllable
	Type of room (office, restroom)	Environmental	Uncontrollable
	Subject area (fine arts, chemistry)	Policy	Semicontrollable
	Amounts of space serviced	Volume	Semicontrollable
Drake	Enrollment changes	Volume	Semicontrollable
	Size of class sections	Policy	Controllable
	Changes in curriculum	Policy	Controllable
Santa Fe	Changes in enrollment	Volume	Semicontrollable
	Type of student program (credit & noncredit)	Policy	Controllable
Wisconsin System	No. of academic programs & courses	Policy	Uncontrollable
	No. of students	Volume	Semicontrollable
	Level of service provided	Policy	Controllable

Step 3. Determine Current Levels of Service for Each Activity and Assign Costs to Each Activity

Current level of service is derived by assessing the amount of effort currently used for each activity. This assessment is based on existing data and administrative judgment. It can then be quantified by using the activity measures designated in Step 2 and by assigning appropriate weights for impact based on the manager's judgment. The current level of service can then be related to the costs of the activity. These costs can be direct or indirect, depending on the purpose for which the information is used. (Chapter 2 described costing techniques that can be used to determine the cost of the current level of service.)

The current levels of service derived for each activity in the four cost studies, using the activity measures identified in Step 2, are described below:

Denison

Activity	Activity Measure	Data Source
Cleaning	Square feet	Wages and costs of materials (payroll and budget)
Heating	Pounds of steam	Size of building in proportion to total cost
Water and sewerage	Gallons	Metered for each building
Electricity	Kilowatts	Metered for each building
Maintenance	Square feet	Listed as special budget items

A standard costing analysis was used to determine the unit costs of each activity. A weighting system was also developed for each activity, based on the type of space (for example, classroom or restroom) and the type of building (such as dormitory or field house). These weights were then multiplied by the assigned square feet to produce weighted square feet for each type of space and each building.

Drake

Activity	Activity Measure	Data Source
Department	Student credit hours	Semester course enrollment (registrar's records)
Major	Student credit hours	Semester course enrollments (registrar's records)
Section	Student credit hours	Semester course enrollments (registrar's records)

To determine the total instructional capacity at Drake, faculty were asked to designate the maximum capacity for their course sections. This figure was then compared to the actual enrollment levels for the course sections. Aggregating the excess capacity levels to majors and departments proved a problem because the distribution of different capacities varied among all course sections. A simple average capacity figure for majors and departments obscured the wide range of capacities that existed for courses. This problem was resolved by a weighted capacity formula computed to account for the wide ranges of capacity levels within majors and departments.

Santa Fe

Activity	Activity Measure	Data Source
Financial aid	Student headcount	Enrollment (registrar's records)
Admissions	Student headcount	Enrollment (registrar's records)
Counseling	Student headcount	Enrollment (registrar's records)

The cost of each activity was based on actual expenditures for a given fiscal year. Santa Fe excluded program expenditures involving federal grants and contracts. The purpose of the study was to investigate the effects of enrollments and enrollment mix by academic program on student services. Thus, a weighting system was devised to reflect the relative impact of the academic program on student services.

Wisconsin System

Activity	Activity Measure	Data Source
Technical services	Number of academic programs	Catalog
Information services	FTE students	Data on program and enrollment in the four pilot institutions (registrar's records)

The cost for each activity was based on the budgeted amount for a fiscal year. FTE students were weighted to reflect the fact that higher level students normally make more extensive use of a library's information services. Librarians also determined that 30 academic programs represent the standard base for examining technical services.

Step 4. Determine the Behavior of Costs for Each Activity

Step 3 established current levels of service for an activity, current costs of an activity, and a weighting system for each factor relative to its influence on the costs of an activity. The purpose of Step 4 is to manipulate the current level of service and other volume, policy, or environmental factors to monitor the effect of hypothetical changes on costs.

If this exercise is to be meaningful for making decisions, current levels of service must be manipulated within reasonable volume ranges. For example, an increase or decrease in enrollment of 50%–60% would have more than a proportional impact on costs because so many other activities would also be affected. The same is true for manipulating policy decisions. If basic realities are altered to the point where they become unrealistic, the value of performing the analysis is severely limited.

Denison. Standard costs were used as the basis of this study. The cost behavior characteristics of operations and maintenance were expressed solely in terms of variable costs because, for purposes of this study, fixed costs were not relevant to the changing costs of operations and maintenance. A variable unit cost was produced when the weights for each type of service (derived in Step 3) were assigned to square feet (by type of space and building). Variable unit costs could then be used to indicate changes in activity costs if the current level of service were altered.

Drake. The cost behavior characteristics for instruction were expressed in terms of excess capacity. Excess capacity is the difference between capacity and enrollment and is a way of determining classroom and faculty utilization. Imputed costs for unused student credit hours could be determined for each course. Variables such as changes in enrollment or university curriculum would indicate the imputed costs for a given situation.

Santa Fe. Standard costs were determined for each student service, and the cost behavior characteristics for student services were expressed in terms of both fixed and variable costs. Managers studied the tasks and procedures of each activity and determined whether costs were fixed or variable in relation to changes in enrollment. Variable costs for each task were divided by the weighted student headcount to determine a unit cost for the activity and then summed for each activity. This procedure enabled managers to multiply the variable unit cost by enrollment levels for each student program to determine total variable cost.

Wisconsin System. Standard costs were the basis for this study; cost behavior characteristics for the library's information services were expressed in terms of fixed and variable costs. An analysis of minimum library services and minimum staffing levels was used as the basis for determining fixed costs. Demands for services beyond the fixed level of costs were determined by relating total FTE staff to total weighted FTE students. Changes in enrollment levels influenced the variable component cost of information services.

The cost behavior characteristics for technical services of the library were also expressed in terms of fixed and variable costs. Fixed costs were determined by using standards that related numbers of volumes acquired to number and type of academic programs. An annual book replacement figure was included in this calculation. Demands for technical services beyond the fixed amount were determined by numbers of additional volumes. These items were considered variable costs.

Step 5. Evaluate and Document the Policy Implications of the Study

Once the cost behavior model has been established, a manager should be able to perform a series of computations that specifically address the policy questions identified at the beginning of the study. This cost information, with considerations of quality and objectives, provides the basis for a tradeoff between different policy alternatives. Managers should be able to document ways in which the results of the study can affect future policies.

Denison. The policy question at Denison was how to gain optimum use of resources for operation and maintenance of the physical plant. Cost behavior analysis enabled the vice president for finance and management to answer some specific questions. For example, the analysis determined the direct costs for operation and maintenance of Slayton Hall (more than $76,000) and the amount that could be saved by reducing office cleaning from five to two days per week (approximately $5,800). While this cost information helps establish various policy alternatives, factors such as faculty complaints and the effect on building appearance also must be weighed. After evaluating all the costs

and benefits, the vice president could determine the acceptability of reducing cleaning to twice a week.

Drake. The measures of capacity and utilization for the cost behavior analysis permitted the identification of course sections that were not filled to capacity. In conjunction with cost benefit analysis, managers could determine the benefits of admitting a certain number of students or dropping the course. If this kind of study were performed annually, it would assist deans and department heads to assign faculty and to justify budget requests.

Santa Fe. The policy question at Santa Fe was how resources were distributed among student services. Cost behavior analysis enabled managers to develop a cost model that estimates the effect of changes in enrollment levels and mix on the costs of various student services. For example, the analysis determined that an increase of 280 in the number of students in the advanced and professional program increased the cost for student activities 10 times more than the increase of 280 in the number of high school students. This information enabled managers to estimate the impact of fall enrollments on the cost of student services. Such information could also be useful in making a case for altering state allocation formulas based on FTE enrollments and in reexamining current assumptions about the counseling needs of different students to determine whether the benefits are worth the costs.

Wisconsin System. Cost behavior analysis enabled managers to divide fixed costs of libraries into two categories—technical services and public information. By determining the number of academic programs in an institution's curriculum and by identifying changes in enrollments, state administrators can recommend changes to the funding formula for libraries.

These levels of fixed costs are also important because they represent minimum levels of service for both technical and information activities. If resources for these activities were cut below this level of service, the institution's ability to maintain a library would be seriously threatened.

four • denison: operation & maintenance of physical plant

Denison University, in Granville, Ohio, is an independent undergraduate institution with an enrollment of slightly more than 2,000. The physical plant consists of 51 major buildings with more than 1.2 million square feet of space. The plant investment totals $31,000,000 at cost and $62,000,000 in replacement value. The campus was developed over a 50-year period from 1923 to 1973. A further 30-year plan will take Denison into the twenty-first century.

For the last 25 years, Denison has operated with a balanced budget. Nevertheless, over the last five years, expenditures for operations and maintenance (O&M) have increased at a faster rate than other expenditures, as shown in Table 2. In the past, costs for O&M were assigned to functions and buildings on the basis of net assigned square feet per building. The information thus derived reflected the total cost of O&M apportioned among buildings on campus by size of the buildings but gave no clue as to what factors influenced the cost of operating and maintaining the buildings. Thus, to improve knowledge of O&M costs, the vice president for business affairs and the director of physical plant proposed an assessment of the current philosophy for use in developing a cost model that could help determine future policy changes in the operation of the physical plant.

Table 2

	Current Expenditures		Percent Increase	
	Plant O&M	Total	O&M	Total
1973–74	$ 811,713	$ 9,476,475		
1974–75	794,470	10,211,884	– 2.1%	+ 7.8%
1975–76	911,629	11,281,071	+ 14.7	+ 10.5
1976–77	1,017,355	12,004,499	+ 11.6	+ 6.4
1977–78	1,122,079	12,797,761	+ 10.3	+ 6.6
4-Year Rate			+ 8.6%	+ 7.8%

Unit Costing of Physical Plant Services

Conventional cost accounting assigns expenditures for the physical plant back to functions, buildings, or departments on the basis of net assigned square feet of space. This is relatively simple but can be quite erroneous. For example, the cost of cleaning an office is different from the cost of cleaning a restroom or a laboratory, even though they may contain an equal amount of square feet. Similarly, the energy requirements of a poorly insulated frame structure are significantly different from those of a well insulated brick building of the same size.

In a 1978 study, "Comparative Costs and Staffing Report for Physical Plants of Colleges and Universities," the Association of Physical Plant Administrators of Universities and Colleges provides evidence of the inaccuracy of using assigned square feet as the basis for costing. The study applied eight predictive models to each of five physical plant cost areas for 145 colleges and universities. In no case was there a useful relationship between the 40 predictive cost curves and the difference in the cost per square foot that occurs as the total square footage changes. In the most important cost areas—utilities, custodial service, and maintenance—most of the predictive curves explained less than 1% of the variance. It was therefore determined that the cost behavior analysis at Denison should include recognized differences occasioned by (1) the kind and level of services offered, and (2) the character and use of space served. The costing units adopted for this study are impact-weighted square feet (IWSF) by type of service.

Step 1. Determine Policy Questions and Identify the Management Level Served by the Study

Several questions led to the study:

1. How much could be saved by cutting office custodial services to two days a week?
2. Where is the most money spent on heating, and can it be reduced?
3. What savings might be achieved by closing building X?

These questions and others clearly indicated a need for cost data that permitted analysis of cost variations by kind of service, level of service, building, type of space, subject field, or any combination of these factors.

It was decided that the study should directly support the director of physical plant. It should enable him to answer his superiors' questions about O&M within one day and in a manner that is comprehensible to the building services supervisor.

Step 2. For Each Function Under Study, Identify the Activities, Activity Measures, and Factors that Affect Costs

Initially, ten kinds of service activities were defined:

1. Cleaning
2. Heating
3. Electricity
4. Water and sewerage
5. Maintenance
6. Air conditioning
7. Grounds maintenance
8. Remodeling
9. Administration
10. Other (see Exhibit 4.1)

Subsequently, only the first five services were selected for the study because air conditioning costs are reflected in the expenditures for electricity and maintenance; grounds costs are well known and experiments with varying levels of service had already satisfied management about that service; and remodeling, administration, and "other" do not usually involve decisions that affect other areas of O&M.

An impact-weighted square foot (IWSF) was selected as the measure to represent the relative amount of each service produced.[1] For example, the amount of time spent cleaning a classroom was assigned an impact of **1**. In relationship to this factor, the amount of time spent cleaning a restroom has an impact of **3**. IWSF are derived by multiplying the assigned square feet for a type of space by the impact number for that type of space.

Step 3. Determine Current Levels of Service for Each Activity and Assign Costs to Each Activity

The director of physical plant defined the current level of service for each activity as follows:

1. Cleaning: most space cleaned daily.
2. Heating: 68°F.
3. Electricity: Recommended lighting standards and unlimited hours of operation.
4. Water and sewerage: as required.
5. Maintenance: as required.

Calculating IWSF and costs for each activity required three steps: (1) selecting the basic costing module, (2) determining cost, and (3) determining impact factors for each service. To select the basic costing module, areas were grouped by room type within a subject field (where applicable) within a building. For example, classrooms used for teaching English in one building constituted one module, while general administrative offices in the building constituted another. This decision was based on the number of records that would be involved. Such a grouping significantly reduced the number of records.

Data on direct expenditures were used to determine costs for each service.

Cleaning	
Wages	$226,385
Materials	20,386
Trash collection	7,000
	$253,771
Heating	
Heating plant expense	$376,962
Wages for system maintenance	28,320
Maintenance materials	24,000
Supervision	8,260
	$437,542

[1]Impact-weighted number of rooms was considered as a measurement of the effect of water and sewerage on costs. Most rooms would have had an impact of 0, those with a single toilet an impact of 1, those with more toilets or shower rooms a higher impact. However, because each building has a water meter, it seemed more appropriate to assign impacts for water on a relative cost per square foot.

Electricity	
Utility cost	$219,280
Water and sewerage	
Total bills	$105,186
Maintenance	
Total expense	$221,778

Five sets of factors were developed from various sources of data to determine impact factors for each service. The first was differentiated by type of room, the remainder by building.

1. **Cleaning.** A standard impact of **1** was assigned to the service required to clean a classroom. Impacts for other types of rooms were derived from detailed work assignment files maintained by the building supervisor.

2. **Heating.** A steam meter reading was available for 12 major buildings. The total pounds of steam consumed per square foot was calculated for each building; this ranged from 11 to 108 pounds per square foot. A standard of 50 pounds per square foot was assigned an impact of **1**; other rates of consumption were assigned impacts accordingly.

3. **Electricity.** Thirty-three major buildings have electric meters. The kilowatts used per square foot in these buildings ranged from 2 to 24. A standard impact of **1** was assigned to 2 kilowatts per square foot; other rates of use were assigned impacts accordingly.

4. **Water and sewerage.** The metered cost per square foot per year was calculated for each building; this ranged from $.06 to $.295 per square foot. A standard impact of **1** was assigned to the mean of $.083; impacts for other buildings were calculated by dividing their cost per square foot by $.083.

5. **Maintenance.** A standard impact of **1** was assigned to a building without air conditioning and **2** to an air-conditioned building. Other impacts were estimated within this range. This factor was the least scientific in the study and was regarded as only a starting point. Denision is attempting to develop a more sophisticated factor based on age of building, type of construction, and presence of air conditioning.

Step 4. Determine the Behavior of Costs for Each Activity

When the impact weights for each service were applied to the assigned square feet, the variable unit costs illustrated in Table 3 resulted:

Table 3

Service	IWSF	Direct Cost	Direct Cost per IWSF
Cleaning	764,307	$ 253,771	$0.332
Heating	962,456	437,542	.455
Electricity	3,526,177	219,280	.062
Water and sewerage	1,140,220	105,186	.092
Maintenance	1,569,585	221,778	.141
		$1,237,557	

These variable unit cost components are not comparable because they represent different bases. They are useful for calculating the costs of groups of space such as "all classrooms" or "building X" or "all English classrooms."

Three items of data were necessary to determine the behavior of costs: (1) total costs by type of service (see Step 3), (2) impact factors, and (3) a room inventory by building report. The room inventory report is the most difficult to assemble. It should contain one record for each room showing room type, building, subject taught (if applicable), and assigned square feet. Although a physical plant manager does not typically use such reports, they contain the most relevant data base for any physical plant management system. Because there are nearly 4,000 rooms in Denison's inventory, rooms were aggregated by type and subject taught within a building (see Exhibit 4.2). This exercise required three days to complete and resulted in 699 records.

The COMSHARE network and its proprietary COMPOSITE 77 data management language were used to assign impact factors, calculate IWSF, and calculate costs by service. All calculations were performed interactively from an office terminal. Briefly, the procedure involved the following steps:

1. **Basic Data**

   - Room records, with one record for each room type–subject combination (699 records), each containing building code, room type code, subject code, number of rooms, and assigned square feet.
   - Building description and service impact (51 records—see Exhibit 4.3), each containing building code, building description, heating impact, electricity impact, water and sewerage impact, and maintenance impact.
   - Room type description and service impact (70 records—see Exhibit 4.4), each containing room type code, room type description, and cleaning impact.
   - Subject field description (38 records), each containing subject code, subject description, and service impact.

2. **Computing Steps**

   - Add building, room type, and subject descriptions and impact weights to aggregate room file by table.
   - Calculate impact-weighted square feet by building, by type of room, and by subject area for each service in each record of room file and total (see Exhibits 4.5, 4.6, and 4.7).
   - Develop the impact-weighted unit costs (see Table 3) and use them to calculate a direct service cost (for example, cleaning cost) for each service and a traditional cost total for each record in the room file.
   - Sum the resultant costs in the room file: by building (see Exhibit 4.8), by room type (see Exhibit 4.9), and by subject (see Exhibit 4.10).

Step 5. Evaluate and Document the Policy Implications of the Study

Exhibits 4.8, 4.9, and 4.10 are useful management reports and can be used directly to assist in the analysis of many complex policy questions. To illustrate, consider three typical questions.

1. Where is the most money spent on heating?
The HEATCOST column of Exhibit 4.8 indicates that the five most expensive buildings to heat are:

Field house	$66,595
Chemistry building	40,907
Crawford Hall	27,000
Knapp Hall	25,215
Burke Hall	23,137

2. What could be saved by reducing administrative office cleaning from five to two days a week?
The cleaning cost for administrative offices shown in Exhibit 4.9 is $9,678. Approximately three-fifths of this cost, or $5,807, could be saved by cleaning the offices two rather than five days per week.

3. What are the total direct costs for servicing Slayter Hall?
Exhibit 4.8 indicates the costs for Slayter Hall as follows:

Cleaning	$13,510
Heating	20,495
Electricity	24,920
Water and sewerage	3,235
Maintenance	14,156
	$76,316

This knowledge would be a good starting point for assessing potential savings from closing the building.

Each of these questions took less than a minute to answer, using the management analysis reports shown in Exhibits 3.7, 3.8, and 3.9. These management data can be used to answer far more complex questions by writing other short programs. For example, comparing impact-weighted costs with traditional costs was completed in 15 minutes with another program. This step produced the report shown as Exhibit 4.11.

- The biggest percentage difference was for the warehouse; traditional costing assigned costs of $14,373, while impact-weighted costing was only $549.
- Traditional costing underestimated the costs associated with the field house by nearly $43,000 per year and those for the chemistry building by more than $40,000 per year.
- Traditional costing overestimated or underestimated costs by 25% or more in 30 out of the 51 buildings.

Exhibit 4.1

Service Activities Defined

1. The director of physical plant defined the service activities as follows:

   Cleaning: vacuum, mop, dust, etc., all space. Change light bulbs and collect trash.

   Heating: Cost to produce and distribute steam.

   Electricity: Cost to purchase electric power.

   Water and sewerage: Cost to purchase utility.

   Maintenance: Cost to maintain buildings and equipment and to service buildings.

   Air conditioning: Cost of electricity consumption and maintenance of air-conditioning equipment.

   Grounds maintenance: Cost to maintain roads and grounds.

   Remodeling: Cost to change building configuration and cost for major replacements such as roofs.

   Administration: Cost to administer the physical plant.

   Other: Including equipment replacement.

PHYSICAL PLANT COST IMPACT MODEL DATA SHEET
Denison University

Bldg. No. A014
Name Library Addition
Built 1958
Remodeled
Condition Satisfactory
Air Conditioning 10%

Related Roads and Grounds		Acres	Grounds	Other
	Intensive Care			
	Rustic			
	No Maintenance			

	Rooms	Square Feet
Gross Space	45	27,534

Unassignable		Rooms	Square Feet	Capacity	Cleaning	Heating	Electricity	Water & Sewerage	Air Cond.	Maintenance	Remodel	Other
010	Custodial	6	346		0.5							
020	Circulation	13	1,656		2.0							
030	Mechanical	1	28		0.2							
035	Toilet	4	445		3.0							
040	Structural		2,581									
	TOTAL	24	5,056									

Exhibit 4.2 (continued)

Bldg. No. A014

Name Library Addition

Room Type

Code	Description	Subject Field	No. of Rms.	Assigned Sq. Ft.	Capacity	Cleaning	Heating	Electricity	Water & Sewerage	Air Cond.	Maintenance	Remodel	Other
311	Admin. Offices		1	292		1.0							
313	General Offices		1	589		1.0							
410	Reading & Study		9	2,977		1.0							
420	Stacks		3	4,283		0.5							
430	Open Stock		4	11,485		1.0							
440	Study Service		3	2,852		1.0							
		TOTAL	21	22,478									

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COMMENTS:

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COST IMPACT FACTORS BY BUILDING
Denison University

Bldg. Code	Bldg. Description	Built	Remodeled	Condition	Heat Impact	Elec. Impact	Water Impact	Maint. Impact
A014	LIBRARY ADDITION	1958	0	1	0.70	4.00	0.30	1.50
A017	CURTIS WEST ADDITION	1968	0	1	0.60	8.00	1.50	2.00
A030	SWIMMING POOL	1962	0	1	2.00	3.00	0.60	1.50
0001	STONE HALL	1905	0	1	0.70	1.00	0.00	1.00
0002	KING HALL	1891	0	1	0.60	1.50	1.90	1.00
0006	THEATRE ART	1956	0	1	1.00	2.00	0.10	1.50
0008	MIDDLETON	1915	0	1	0.00	0.00	0.00	1.00
0009	MONOMOY	1905	0	1	0.00	0.00	0.00	0.00
0010	SLAYTER HALL	1962	0	1	0.90	8.00	0.70	2.00
0011	CLEVELAND HALL	1904	0	1	0.70	1.00	0.40	1.00
0012	DOANE ADMINISTRATION	1892	0	1	0.50	1.50	0.20	1.00
0013	BARNEY SCIENCE	1906	0	1	0.50	2.00	0.20	1.00
0014	LIBRARY	1937	0	1	0.70	4.00	0.30	1.50
0015	CHEMISTRY BLDG.	1966	0	1	2.00	5.00	1.50	2.00
0016	CURTIS EAST	1945	0	1	0.60	2.00	3.60	1.00
0017	CURTIS WEST	1939	0	1	0.60	1.50	1.50	1.00
0018	SMITH HALL	1953	0	1	0.60	2.00	2.70	1.50
0019	LIFE SCIENCE	1941	0	1	0.50	1.00	0.60	1.00
0020	KNAPP HALL	1969	0	1	0.80	5.00	0.20	2.00
0021	BETH EDEN	1901	0	1	0.70	1.00	0.30	1.00
0022	CHAPEL	1922	0	1	1.00	1.00	0.10	1.00
0023	OBSERVATORY	1909	0	1	0.00	5.00	0.10	1.00
0024	COLWELL	1890	1968	1	0.60	1.50	0.70	1.00
0025	GILPATRICK	1905	1960	2	0.60	1.00	1.10	1.00
0026	EAST HALL	1953	0	1	0.60	2.00	2.20	1.00
0027	SHAW HALL	1939	0	1	0.60	1.00	2.00	1.00
0028	BEAVER HALL	1924	0	1	0.60	1.50	2.00	1.00
0029	SAWYER HALL	1924	0	1	0.60	1.50	2.00	1.00
0030	FIELD HOUSE	1951	0	1	2.00	3.00	0.60	1.50
0031	STADIUM	1922	0	1	1.00	1.00	2.90	0.50
0032	LAMSON LODGE	1940	0	1	0.00	0.00	0.00	0.50
0033	FELLOWS HALL	1965	0	1	0.60	8.00	0.40	2.00
0034	CARPENTER	1941	0	1	0.00	1.0	0.00	0.50
0035	HEATING PLANT	1946	0	1	0.00	1.00	0.00	1.00
0036	WHISLER HOUSE	1929	0	1	0.60	1.00	0.10	1.00
0037	BURKE HALL	1973	0	1	1.60	4.00	0.60	1.50
0038	CRAWFORD HALL	1960	0	1	1.10	2.00	1.80	1.50
0039	HUFFMAN HALL	1960	0	1	1.00	2.50	1.20	1.50
0040	SHORNEY HALL	1967	0	1	0.40	2.00	2.10	1.50
0042	SHEPARDSON HALL	1968	0	1	1.00	2.50	1.50	1.50
0043	QUONSET HUT	1948	0	1	0.00	1.00	0.00	0.50
0044	WAREHOUSE	1963	0	1	0.00	0.20	0.00	0.20
0045	WOMENS FIELD HOUSE	1928	0	3	0.00	0.20	0.00	0.20
0046	MONOMOY COTTAGE	1905	0	1	1.00	0.50	1.10	0.50
0047	NEW PHYSICAL PLANT	1969	0	1	0.00	2.00	0.00	1.00
0048	PRESIDENTS NEW HOUSE	1970	0	1	0.00	0.00	0.50	1.00
0049	ART DEPT. ANNEX	1940	1971	1	0.00	0.00	0.20	1.00
0050	ATO DORM	1964	0	1	0.00	0.00	12.00	1.00
0051	DELTA CHI	1911	0	1	0.00	0.00	0.00	1.00
0052	DOANE DANCE	0	1975	1	1.50	2.00	0.30	1.00
0053	CINEMA ANNEX	1933	0	1	5.00	2.00	0.20	1.00
9999	TOTALS	0	0	1	0.00	0.00	0.00	0.00

Exhibit 4.3

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Exhibit 4.4

COST IMPACT FACTORS BY TYPE OF ROOM
Denison University

Room Type Code	Room Description	Clean Impact
0	NONASSIGNABLE	0.00
10	CUSTODIAL	0.30
20	CIRCULATION	2.00
30	MECHANICAL	0.00
35	TOILET & RESTROOM	3.00
40	STRUCTURAL AREA	0.00
81	INACTIVE	0.00
100	CLASSROOM FACILITIES	0.00
110	CLASSROOM	1.00
115	CLASSROOM SERVICE	0.50
120	LECTURE HALL	0.80
125	LECTURE HALL SERVICE	0.50
130	SEMINAR ROOM	1.00
210	TEACHING LAB	2.00
215	TEACHING LAB SERVICE	1.00
220	UNSCHED. TEACHING LAB	2.00
225	UNSCHED. TEACHING LAB SERV.	1.00
230	INDIV. STUDY LAB	1.50
235	INDIV. STUDY LAB SERV.	1.00
250	RESEARCH LAB	1.00
255	RESEARCH LAB SERVICE	1.00
310	FACULTY OFFICE	1.00
311	ADMINISTRATIVE OFFICE	1.20
312	STUDENT ACTIVITY OFFICE	1.20
313	GENERAL OFFICE	1.20
315	OFFICE SERVICE	0.50
350	CONFERENCE ROOM	1.00
355	CONF. ROOM SERVICE	0.50
410	READING & STUDY	1.20
420	STACK	0.50
430	OPEN-STACK & RDG. ROOM	1.00
440	STUDY SERVICE	0.50
455	LIB. & STUDY SERVICE	1.00
515	ARMORY SERVICE	0.00
520	ATHLETIC & PE	0.80
523	ATHLETIC & PE SEATING	2.00
525	ATHLETIC & PE SERVICE	0.50
530	A-V, RADIO & TV	2.00
535	A-V, RADIO & TV SERVICE	2.00
550	DEMO. FACILITIES	1.00
570	ANIMAL QUARTERS	2.00
610	ASSEMBLY FACILITIES	1.00
611	ASSEMBLY SEATING & AISLES	0.80
612	ASSEMBLY STAGE, ETC.	1.00
615	ASSEMBLY SERVICE, ETC.	0.50
620	EXHIBIT & MUSEUM	1.00
625	EXH. & MUSEUM FAC. SERV.	0.50
630	FOOD SERVICE	0.00
640	STU. HEALTH SERVICE	0.00
650	LOUNGE	1.00
660	MERCHANDISING FACILITIES	1.50
670	RECREATION FACILITIES	1.00
710	DP/COMPUTER FACILITIES	2.00
715	DP/COMP. FAC. SERVICES	0.50
720	SHOP	0.00
725	SHOP SERVICE	0.00
730	STORAGE & SUPPLY	0.00
740	VEHICLE STORAGE	0.00
750	CENTRAL FOOD STOR. & PREP	0.00
760	CENTRAL LAUNDRY	0.00
911	STUDENT RES. ROOM	0.00
915	RESIDENTIAL SERV. (CENTRAL)	0.00
916	LIVING ROOM STUDY	0.00
917	KITCHEN	0.00
918	TOILET/WASH PRIVATE SERV.	0.00
919	OTHER SERV. STOR. ETC.	0.00
922	ONE FAMILY DWELLING—STAFF	1.00
933	MULTI FAMILY DWELLING—ADV	0.00
934	MULTI FAM. DWELLING—GUEST	0.00
0	TOTALS	0.00

IMPACT-WEIGHTED SQUARE FEET BY BUILDING AND SERVICE TYPE

Denison University

Bldg. Code	Bldg. Description	No. Rooms	Asgn. SQFT	Clean SQF	Heat SQF	Elec. SQF	Water SQF	Maint. SQF
A014	LIBRARY ADDITION	45	27,534.	24,432.	19,273.	110,136.	8,260.	41,301.
A017	CURTIS WEST ADDITION	64	33,598.	10,638.	20,158.	268,784.	50,397.	67,196.
A030	SWIMMING POOL	19	17,082.	16,421.	34,164.	51,246.	10,249.	25,623.
0001	STONE HALL	37	22,500.	9,603.	15,749.	22,500.	0.	22,500.
0002	KING HALL	45	12,120.	4,484.	7,271.	18,180.	23,027.	12,120.
0006	THEATRE ART	46	21,776.	29,527.	21,776.	43,552.	2,177.	32,664.
0008	MIDDLETON	2	7,344.	0.	0.	0.	0.	7,344.
0009	MONOMOY	52	14,774.	7,526.	0.	0.	0.	0.
0010	SLAYTER HALL	68	50,092.	40,606.	45,082.	400,736.	35,064.	100,184.
0011	CLEVELAND HALL	32	25,752.	31,350.	18,026.	25,752.	10,300.	25,752.
0012	DOANE ADMINISTRATION	86	26,327.	23,879.	13,163.	39,490.	5,265.	26,327.
0013	BARNEY SCIENCE	66	26,967.	29,346.	13,483.	53,934.	5,393.	26,967.
0014	LIBRARY	42	26,146.	18,850.	18,303.	104,592.	7,844.	39,222.
0015	CHEMISTRY BLDG.	92	44,992.	44,667.	89,984.	224,960.	67,488.	89,984.
0016	CURTIS EAST	101	24,568.	10,551.	14,740.	49,136.	88,444.	24,568.
0017	CURTIS WEST	100	22,886.	11,285.	13,731.	34,329.	34,329.	22,886.
0018	SMITH HALL	108	25,110.	9,416.	15,065.	50,220.	67,796.	37,665.
0019	LIFE SCIENCE	77	35,747.	43,297.	17,873.	35,747.	21,448.	35,747.
0020	KNAPP HALL	199	69,331.	63,863.	55,464.	346,655.	13,866.	138,662.
0021	BETH EDEN	1	6,654.	6,090.	4,657.	6,654.	1,996.	6,654.
0022	CHAPEL	25	21,896.	16,663.	21,896.	21,896.	2,189.	21,896.
0023	OBSERVATORY	8	2,183.	3,011.	0.	10,915.	218.	2,183.
0024	COLWELL	40	12,890.	8,842.	7,733	19,335.	9,022.	12,890.
0025	GILPATRICK	23	5,688.	2,039.	3,412.	5,688.	6,256.	5,688.
0026	EAST HALL	115	24,740.	10,910.	14,843.	49,480.	54,427.	24,740.
0027	SHAW HALL	150	26,080.	9,378.	15,647.	26,080.	52,160.	26,080.
0028	BEAVER HALL	169	22,089.	5,342.	13,253.	33,133.	44,178.	22,089.
0029	SAWYER HALL	168	22,089.	5,431.	13,253.	33,133.	44,178.	22,089.
0030	FIELD HOUSE	60	73,245.	63,512.	146,490.	219,735.	43,946.	109,867.
0031	STADIUM	30	23,331.	6,130.	23,331.	23,331.	67,659.	11,665.
0032	LAMSON LODGE	3	1,025.	1,072.	0.	0.	0.	512.
0033	FELLOWS HALL	148	46,583.	54,630.	27,949.	372,664.	18,633.	93,166.
0034	CARPENTER	2	2,611.	0.	0.	2,611.	0.	1,305.
0035	HEATING PLANT	4	7,314.	0.	0.	7,314.	0.	7,314.
0036	WHISLER HOUSE	46	11,160.	4,314.	6,695.	11,160.	1,115.	11,160.
0037	BURKE HALL	20	31,809.	18,099.	50,894.	127,236.	19,085.	47,713.
0038	CRAWFORD HALL	255	53,992.	25,666.	59,391.	107,984.	97,185.	80,988.
0039	HUFFMAN HALL	183	48,043.	17,141.	48,043.	120,107.	57,651.	72,064.
0040	SHORNEY HALL	214	48,637.	23,863.	19,454.	97,274.	102,137.	72,955.
0042	SHEPARDSON HALL	259	38,125.	18,548.	38,125.	95,312.	57,187.	57,187.
0043	QUONSET HUT	4	4,077.	285.	0.	4,077.	0.	2,036.
0044	WAREHOUSE	3	13,500.	0.	0.	2,699.	0.	2,699.
0045	WOMENS FIELD HOUSE	3	831.	408.	0.	166.	0.	166.
0046	MONOMOY COTTAGE	15	2,682.	1,137.	2,682.	1,341.	2,950.	1,341.
0047	NEW PHYSICAL PLANT	26	33,000.	3,182.	0.	66,000.	0.	33,000.
0048	PRESIDENTS NEW HOUSE	1	5,685.	6,193.	0.	0.	2,842.	5,685.
0049	ART DEPT. ANNEX	21	4,792.	4,374.	0.	0.	958.	4,792.
0050	ATO DORM	0	13,296.	4,923.	0.	159,576.	0.	13,296.
0051	DELTA CHI	0	9,000.	2,624.	0.	0.	0.	9,000.
0052	DOANE DANCE	13	7,595.	6,633.	11,392.	15,190.	2,278.	7,595.
0053	CINEMA ANNEX	6	3,067.	4,302.	0.	6,134.	613.	3,067.
9999	TOTALS	3274	1,162,359.	764,308.	962,463.	3,526,177.	1,140,227.	1,569,603.

Exhibit 4.5

Exhibit 4.6

IMPACT-WEIGHTED SQUARE FEET BY ROOM TYPE AND SERVICE TYPE

Denison University

Room Type Code	Room Description	No. Rooms	Asgn. SQFT	Clean SQF	Heat SQF	Elec. SQF	Water SQF	Maint. SQF
0	NONASSIGNABLE	0	14,435.	0.	0.	101,544.	0.	14,435.
10	CUSTODIAL	122	4,272.	1,281.	3,773.	13,519.	5,138.	6,000.
20	CIRCULATION	477	142,598.	285,196.	115,785.	447,615.	155,165.	198,745.
30	MECHANICAL	136	48,306.	0.	45,746.	196,287.	43,727.	76,052.
35	TOILET & RESTROOM	121	14,812.	44,436.	12,000.	57,972.	11,505.	22,401.
40	STRUCTURAL AREA	0	187,385.	0.	154,231.	544,366.	210,197.	240,898.
81	INACTIVE	1	72.	0.	36.	144.	14.	72.
110	CLASSROOM	59	37,800.	39,364.	31,907.	155,985.	13,049.	59,814.
115	CLASSROOM SERVICE	29	7,653.	3,826.	7,080.	35,167.	4,969.	12,409.
120	LECTURE HALL	4	7,791.	6,232.	10,153.	36,376.	7,969.	13,612.
125	LECTURE HALL SERVICE	8	1,157.	578.	1,652.	5,400.	1,284.	2,064.
130	SEMINAR ROOM	21	9,368.	9,368.	6,665.	59,665.	3,036.	18,133.
210	TEACHING LAB	35	32,926.	65,852.	33,053.	92,762.	22,901.	47,835.
215	TEACHING LAB SERVICE	58	15,450.	15,450.	16,483.	39,606.	8,579.	22,451.
220	UNSCHED. TEACHING LAB	16	9,333.	18,666.	6,628.	19,387.	2,561.	10,990.
225	UNSCHED. TEACHING LAB SERV	5	3,808.	3,808.	2,343.	5,179.	1,476.	3,808.
230	INDIV. STUDY LAB	21	6,672.	10,008.	4,123.	19,591.	1,845.	8,519.
235	INDIV. STUDY LAB SERV.	4	505.	505.	267.	1,600.	247.	652.
250	RESEARCH LAB	3	1,201.	1,201.	2,005.	5,013.	906.	1,906.
255	RESEARCH LAB SERVICE	2	734.	734.	367.	734.	440.	734.
310	FACULTY OFFICE	158	26,324.	26,324.	21,489.	116,978.	10,052.	43,368.
311	ADMINISTRATIVE OFFICE	101	24,241.	29,089.	16,790.	60,383.	10,895.	29,590.
312	STUDENT ACTIVITY OFFICE	10	3,288.	3,945.	2,815.	23,184.	2,301.	6,096.
313	GENERAL OFFICE	1	589.	706.	412.	2,356.	176.	883.
315	OFFICE SERVICE	72	7,551.	3,775.	6,177.	26,673.	4,160.	10,796.
350	CONFERENCE ROOM	5	2,393.	2,393.	1,942.	9,223.	2,018.	3,804.
355	CONF. ROOM SERVICE	5	340.	170.	235.	880.	286.	424.
410	READING & STUDY	45	12,559.	15,070.	9,137.	38,390.	12,041.	17,123.
420	STACK	15	19,304.	9,652.	13,512.	77,216.	5,791.	28,956.
430	OPEN-STACK & RDG. ROOM	6	12,652.	12,652.	8,856.	50,608.	3,795.	18,978.
440	STUDY SERVICE	6	3,648.	1,824.	2,553.	14,592.	1,094.	5,472.
455	LIB. & STUDY SERVICE	5	415.	415.	290.	1,660.	124.	622.
515	ARMORY SERVICE	5	1,204.	0.	842.	1,204.	0.	1,204.
520	ATHLETIC & PE	12	64,898.	51,758.	118,964.	213,039.	38,621.	97,861.
523	ATHLETIC & PE SEATING	1	3,675.	7,350.	7,350.	11,025.	2,205.	5,512.
525	ATHLETIC & PE SERVICE	54	16,169.	8,084.	22,016.	30,448.	20,072.	16,642.
530	A-V, RADIO & TV	1	325.	650.	260.	1,625.	64.	650.
535	A-V, RADIO & TV SERVICE	5	570.	1,140.	390.	2,083.	113.	921.
550	DEMO. FACILITIES	1	95.	95.	76.	475.	18.	190.
570	ANIMAL QUARTERS	1	109.	218.	87.	545.	21.	218.
610	ASSEMBLY FACILITIES	3	2,986.	2,986.	4,777.	11,944.	1,791.	4,479.
611	ASSEMBLY SEATING & AISLES	4	13,101.	10,480.	14,741.	35,324.	3,806.	17,070.
612	ASSEMBLY STAGE, ETC.	7	6,717.	6,717.	8,491.	18,363.	2,290.	9,038.
615	ASSEMBLY SERVICE, ETC.	6	1,367.	683.	1,637.	4,495.	489.	1,984.
620	EXHIBIT & MUSEUM	2	2,002.	2,002.	3,203.	8,008.	1,201.	3,003.
625	EXH. & MUSEUM FAC. SERV.	2	1,155.	577.	1,848.	4,620.	693.	1,732.
630	FOOD SERVICE	53	33,697.	0.	26,637.	200,416.	42,454.	60,229.
640	STU. HEALTH SERVICE	38	5,754.	0.	3,452.	5,754.	575.	5,754.
650	LOUNGE	45	26,085.	26,085.	21,946.	94,610.	35,327.	37,500.
660	MERCHANDISING FACILITIES	5	5,335.	8,002.	4,749.	41,111.	3,472.	10,670.
670	RECREATION FACILITIES	21	11,888.	11,888.	8,621.	49,616.	15,787.	17,092.

Room Type Code	Room Description	No. Rooms	Asgn. SQFT	Clean SQF	Heat SQF	Elec. SQF	Water SQF	Maint. SQF
710	DP/COMPUTER FACILITIES	2	1,202.	2,404.	721.	9,616.	480.	2,404.
715	DP/COMP. FAC. SERVICES	2	160.	80.	95.	1,280.	63.	320.
720	SHOP	13	23,051.	0.	1,034.	45,146.	773.	23,051.
725	SHOP SERVICE	6	4,250.	0.	271.	4,660.	487.	2,341.
730	STORAGE & SUPPLY	66	29,106.	0.	11,523.	37,696.	16,683.	20,985.
740	VEHICLE STORAGE	2	9,325.	0.	0.	18,110.	0.	9,325.
750	CENTRAL FOOD STOR. & PREP	8	2,075.	0.	1,838.	8,145.	1,306.	3,704.
760	CENTRAL LAUNDRY	2	1,992.	0.	1,702.	8,956.	2,607.	3,349.
911	STUDENT RES. ROOM	740	149,807.	0.	105,903.	280,422.	296,755.	190,539.
915	RESIDENTIAL SERV. (CENTRAL)	82	13,267.	0.	9,011.	26,825.	21,640.	15,574.
916	LIVING ROOM STUDY	99	16,799.	0.	11,276.	27,225.	31,078.	18,812.
917	KITCHEN	29	2,518.	0.	1,791.	3,765.	3,869.	2,543.
918	TOILET/WASH PRIVATE SERV.	154	17,954.	0.	12,441.	32,973.	35,556.	22,245.
919	OTHER SERV. STOR. ETC.	234	4,561.	0.	3,260.	8,049.	8,083.	5,230.
922	ONE FAMILY DWELLING—STAFF	2	10,581.	10,581.	4,262.	6,090.	4,072.	10,581.
933	MULTI FAMILY DWELLING—ADV	15	17,661.	0.	8,717.	12,453.	0.	17,661
934	MULTI FAM. DWELLING—GUEST	1	1,536.	0.	0.	0.	0.	1,536.
0	TOTALS	3274	1,162,359.	764,308.	962,463.	3,526,177.	1,140,226.	1,569,603.

Exhibit 4.6 (continued)

Exhibit 4.7

IMPACT-WEIGHTED SQUARE FEET BY SUBJECT AND SERVICE TYPE

Denison University

Subj. Code	Subj. Description	No. Rooms	Assgn. SQFT	Clean SQF	Heat SQF	Elec. SQF	Water SQF	Maint. SQF
0	NO SUBJECT	2,664	889,526.00	461,356.25	658,211.50	2,558,591.00	996,380.56	1,156,329.00
401	BIOLOGY/GENERAL	57	21,593.00	30,440.60	11,339.50	23,041.00	13,281.59	21,955.00
701	COMPUTER/INFO/SCI	1	147.00	73.50	88.20	1,176.00	58.80	294.00
801	EDUCATION/GENERAL	12	2,751.00	2,740.70	2,128.20	14,844.00	822.80	5,502.00
835	PHYS. ED.	48	71,718.00	57,991.50	125,998.63	223,387.00	41,506.88	106,500.50
919	ENGINEERING PHYSICS	0	0.00	0.00	0.00	0.00	0.00	0.00
1001	FINE ARTS, GENERAL	12	7,409.00	9,969.00	6,609.49	31,024.50	3,676.40	11,209.00
1002	ART (PAINTING, ETC.)	10	8,710.00	13,154.50	6,096.99	8,710.00	3,484.00	8,710.00
1003	ART HISTORY & APPREC.	5	3,764.00	3,764.00	6,022.40	15,056.00	2,258.40	5,646.00
1004	MUSIC (PERFORMING, ETC.)	2	4,810.00	4,208.00	7,696.00	19,240.00	2,886.00	7,215.00
1005	MUSIC (LIB. ARTS PROG.)	4	1,599.00	2,021.40	1,396.20	5,148.00	312.00	2,106.00
1007	DRAMATIC ARTS	41	21,188.00	26,374.09	20,814.00	48,616.00	4,292.80	30,305.00
1008	DANCE	18	8,030.00	7,660.00	6,352.50	8,470.00	2,029.50	8,030.00
1101	FOREIGN LANG., GEN.	24	6,203.00	6,901.89	3,839.30	41,399.00	2,481.20	11,231.00
1103	GERMAN	1	415.00	498.00	249.00	3,320.00	166.00	830.00
1502	LIT., ENGLISH	24	5,632.00	5,631.00	3,379.20	45,056.00	2,252.80	11,264.00
1504	CLASSICS	2	863.00	863.00	690.40	4,315.00	172.60	1,726.00
1506	SPEECH & DEBATE	15	3,021.00	3,181.50	2,325.80	14,195.00	895.20	5,587.00
1509	PHILOSOPHY	9	2,136.00	2,184.60	1,621.20	9,804.00	427.20	3,960.00
1510	RELIGIOUS STUDIES	11	2,812.00	3,003.00	2,329.80	16,466.00	963.40	5,824.00
1701	MATH., GENERAL	16	5,996.00	6,672.50	3,550.20	30,384.00	1,713.20	9,550.00
1702	STATISTICS	1	240.00	240.00	120.00	480.00	48.00	240.00
1902	PHYSICS, GENERAL	29	9,195.00	10,713.70	4,615.10	19,446.00	1,874.20	9,371.00
1905	CHEM., GENERAL	52	23,016.00	30,296.80	46,032.00	115,080.00	34,524.00	46,032.00
1911	ASTRONOMY	5	1,313.00	2,327.00	0.00	6,565.00	131.30	1,313.00
1914	GEOLOGY	13	6,420.00	8,958.20	3,210.00	12,840.00	1,284.00	6,420.00
2001	PSYCH., GENERAL	78	23,746.00	31,388.49	15,713.29	80,422.50	4,749.18	36,547.00
2004	PSYCH., COUNSELING	0	0.00	0.00	0.00	0.00	0.00	0.00
2006	PSYCHOMETRICS	0	0.00	0.00	0.00	0.00	0.00	0.00
2007	STATISTICS, PSYCH.	0	0.00	0.00	0.00	0.00	0.00	0.00
2204	ECONOMICS	18	3,963.00	3,884.40	3,170.40	19,815.00	792.60	7,926.00
2205	HISTORY	23	3,331.00	2,947.90	1,998.60	26,648.00	1,332.40	6,662.00
2206	GEOGRAPHY	1	238.00	238.00	119.00	476.00	47.60	238.00
2207	POL. SCI. & GOVT.	11	2,327.00	2,373.60	1,861.60	11,635.00	465.40	4,654.00
2208	SOCIOLOGY	10	2,066.00	2,099.40	1,654.40	10,340.00	413.60	4,136.00
2211	AFRO-AM STUDIES	1	291.00	291.00	261.90	2,328.00	203.70	582.00
4901	GEN. LIB. ARTS & SCI.	1	204.00	204.00	183.60	1,632.00	142.80	408.00
9999	MULTI-DISCIPLINE	57	17,684.00	19,455.57	12,779.39	96,226.00	14,549.77	30,473.00
		3,274	1,162,359.00	484,307.08	962,437.77	3,526,156.00	1,140,219.88	1,569,596.50

IMPACT-WEIGHTED COST BY BUILDING
Denison University

Bldg. Code	Bldg. Description	Clean Cost	Heat Cost	Elec. Cost	Water Cost	Maint. Cost	Impact Weighted Total Cost
A014	LIBRARY ADDITION	8,129.01	8,761.98	6,848.95	762.00	5,835.65	30,337.60
A017	CURTIS WEST ADDITION	3,539.54	9,164.31	16,714.89	4,849.12	9,494.50	43,562.16
A030	SWIMMING POOL	5,463.53	15,531.16	3,186.80	945.49	3,620.42	28,747.39
0001	STONE HALL	3,195.29	7,160.04	1,399.19	0.00	3,179.15	14,933.68
0002	KING HALL	1,492.16	3,305.89	1,130.55	2,124.33	1,712.50	9,765.44
0006	THEATRE ART	9,823.96	9,899.50	2,708.34	200.88	4,615.28	27,247.96
0008	MIDDLETON	0.00	0.00	0.00	0.00	1,037.67	1,037.67
0009	MONOMOY	2,504.12	0.00	0.00	0.00	0.00	2,504.12
0010	SLAYTER HALL	13,510.23	20,494.91	24,920.30	3,234.69	14,155.55	76,315.68
0011	CLEVELAND HALL	10,430.72	8,194.91	1,601.42	950.25	3,638.64	24,815.94
0012	DOANE ADMINISTRATION	7,944.86	5,984.21	2,455.77	485.73	3,719.89	20,590.46
0013	BARNEY SCIENCE	9,763.87	6,129.68	3,353.96	497.54	3,810.32	23,555.37
0014	LIBRARY	6,271.81	8,320.93	6,504.19	723.65	5,541.89	27,362.46
0015	CHEMISTRY BLDG.	14,861.22	40,907.26	13,989.43	6,225.76	12,714.34	88,698.02
0016	CURTIS EAST	3,510.53	6,701.26	3,055.59	8,159.03	3,471.35	24,897.75
0017	CURTIS WEST	3,754.87	6,242.47	2,134.79	3,166.85	3,233.69	18,532.67
0018	SMITH HALL	3,133.71	6,849.09	3,123.00	6,254.27	5,321.90	24,681.96
0019	LIFE SCIENCE	14,405.51	8,125.40	2,222.97	1,978.60	5,050.89	31,783.37
0020	KNAPP HALL	21,247.88	25,214.63	21,557.20	1,279.16	19,592.32	88,891.19
0021	BETH EDEN	2,026.19	2,117.46	413.79	184.15	940.18	5,681.77
0022	CHAPEL	5,544.01	9,954.05	1,361.63	201.99	3,093.81	20,155.49
0023	OBSERVATORY	1,001.78	0.00	678.76	20.14	308.45	2,009.13
0024	COLWELL	2,875.53	3,515.92	1,202.37	832.37	1,821.30	10,247.49
0025	GILPATRICK	678.46	1,551.48	353.72	577.19	803.69	3,964.53
0026	EAST HALL	3,630.04	6,748.17	3,076.98	5,020.98	3,495.65	21,971.82
0027	SHAW HALL	3,120.43	7,113.67	1,621.82	4,811.76	3,684.99	20,352.67
0028	BEAVER HALL	1,777.66	6,025.08	2,060.45	4,075.42	3,121.08	17,059.68
0029	SAWYER HALL	1,807.00	6,025.08	2,060.45	4,075.42	3,121.08	17,089.02
0030	FIELD HOUSE	21,131.23	66,595.23	13,864.51	4,054.11	15,523.79	120,968.87
0031	STADIUM	2,039.50	10,606.41	1,450.87	6,241.62	1,648.28	21,986.68
0032	LAMSON LODGE	356.66	0.00	0.00	0.00	72.41	429.08
0033	FELLOWS HALL	17,655.64	12,706.15	23,174.60	1,718.91	13,163.94	68,419.23
0034	CARPENTER	0.00	0.00	182.37	0.00	184.46	346.83
0035	HEATING PLANT	0.00	0.00	454.83	0.00	1,033.44	1,488.27
0036	WHISLER HOUSE	1,435.57	3,044.04	894.00	102.95	1,576.86	6,853.42
0037	BURKE HALL	6,021.98	23,136.90	7,912.34	1,760.63	6,741.70	45,573.55
0038	CRAWFORD HALL	8,539.31	26,999.60	6,715.13	8,965.37	11,443.24	62,662.65
0039	HUFFMAN HALL	5,703.24	21,840.64	7,469.04	5,318.36	10,182.39	50,513.67
0040	SHORNEY HALL	7,939.44	8,844.27	6,049.11	9,422.20	10,308.29	42,563.30
0042	SHEPARDSON HALL	6,171.10	17,331.85	5,927.13	5,275.54	8,080.34	42,785.96
0043	QUONSET HUT	94.82	0.00	253.53	0.00	288.03	636.39
0044	WAREHOUSE	0.00	0.00	167.90	0.00	381.50	549.40
0045	WOMENS FIELD HOUSE	135.91	0.00	10.34	0.00	23.48	169.73
0046	MONOMOY COTTAGE	378.49	1,219.25	83.39	272.16	189.48	2,142.77
0047	NEW PHYSICAL PLANT	1,058.91	0.00	4,104.30	0.00	4,662.75	9,825.96
0048	PRESIDENTS NEW HOUSE	2,060.46	0.00	0.00	262.22	803.27	3,125.94
0049	ART DEPT. ANNEX	1,455.60	0.00	0.00	88.41	677.09	2,221.10
0050	ATO DORM	1,637.99	0.00	9,923.44	0.00	1,878.95	13,440.38
0051	DELTA CHI	873.03	0.00	0.00	0.00	1,271.66	2,144.68
0052	DOANE DANCE	2,206.88	5,179.10	944.61	210.19	1,073.14	9,613.92
0053	CINEMA ANNEX	1,431.31	0.00	381.45	56.59	433.35	2,302.70
		253,771.00	437,542.00	219,280.00	105,186.00	221,778.00	1,237,557.00

Exhibit 4.8

Exhibit 4.9

IMPACT-WEIGHTED COST BY ROOM TYPE
Denison University

Room Type Code	Room Description	Clean Cost	Heat Cost	Elec. Cost	Water Cost	Maint. Cost	Impact Weighted Total Cost
0	NONASSIGNABLE	0.00	0.00	6,314.65	0.00	2,039.60	8,354.25
10	CUSTODIAL	426.40	1,715.36	840.73	473.99	847.77	4,304.25
20	CIRCULATION	94,886.92	52,636.83	27,835.56	14,314.03	28,081.85	217,755.18
30	MECHANICAL	0.00	20,796.86	12,206.37	4,033.84	10,745.81	47,782.88
35	TOILET & RESTROOM	14,784.20	5,455.45	3,605.10	1,061.41	3,165.23	28,071.39
40	STRUCTURAL AREA	0.00	70,114.75	33,852.17	19,390.81	34,037.93	157,395.65
81	INACTIVE	0.00	16.37	8.95	1.33	10.17	36.82
110	CLASSROOM	12,576.35	14,505.34	9,700.13	1,203.78	8,451.45	46,437.06
115	CLASSROOM SERVICE	1,273.11	3,218.66	2,186.91	458.45	1,753.34	8,890.46
120	LECTURE HALL	2,073.70	4,615.71	2,262.09	735.21	1,923.31	11,610.02
125	LECTURE HALL SERVICE	192.47	751.01	335.81	118.54	291.63	1,689.46
130	SEMINAR ROOM	3,116.81	3,030.13	3,710.35	280.09	2,562.11	12,699.48
210	TEACHING LAB	21,909.47	15,026.50	5,768.53	2,112.63	6,758.87	51,576.00
215	TEACHING LAB SERVICE	5,140.33	7,493.32	2,462.95	791.46	3,172.23	19,060.29
220	UNSCHED. TEACHING LAB	6,210.32	3,013.49	1,205.61	236.30	1,552.91	12,218.63
225	UNSCHED. TEACHING LAB SERV.	1,266.95	1,065.28	322.06	136.21	538.05	3,328.55
230	INDIV. STUDY LAB	3,329.74	1,874.75	1,218.29	170.23	1,203.77	7,796.78
235	INDIV. STUDY LAB SERV.	168.02	121.47	99.50	22.80	92.12	503.92
250	RESEARCH LAB	399.58	911.58	311.74	83.83	269.31	1,976.03
255	RESEARCH LAB SERVICE	244.21	166.84	45.64	40.63	103.71	601.03
310	FACULTY OFFICE	8,758.20	9,769.16	7,274.43	927.33	6,127.70	32,856.83
311	ADMINISTRATIVE OFFICE	9,678.20	7,632.97	3,755.00	1,005.07	4,180.93	26,252.18
312	STUDENT ACTIVITY OFFICE	1,312.73	1,279.81	1,441.73	212.32	861.34	5,107.93
313	GENERAL OFFICE	235.16	187.43	146.51	16.30	124.83	710.24
315	OFFICE SERVICE	1,256.14	2,808.37	1,658.78	383.82	1,525.78	7,632.84
350	CONFERENCE ROOM	798.17	883.30	573.58	186.22	537.56	2,976.83
355	CONF. ROOM SERVICE	56.56	106.92	54.76	26.47	59.91	304.61
410	READING & STUDY	5,014.17	4,153.78	2,387.33	1,110.80	2,419.40	15,085.49
420	STACK	3,211.30	6,143.00	4,801.78	534.24	4,091.35	18,781.66
430	OPEN-STACK & RDG. ROOM	4,209.42	4,026.17	3,147.13	350.14	2,681.51	14,414.37
440	STUDY SERVICE	606.86	1,160.88	907.42	100.96	773.17	3,549.29
455	LIB. & STUDY SERVICE	138.07	132.06	103.23	11.49	87.96	472.81
515	ARMORY SERVICE	0.00	383.14	74.87	0.00	170.12	628.13
520	ATHLETIC & PE	17,220.42	54,081.79	13,248.11	3,562.85	13,827.39	101,940.57
523	ATHLETIC & PE SEATING	2,445.40	3,341.35	685.60	203.41	778.89	7,454.66
525	ATHLETIC & PE SERVICE	2,689.78	10,008.74	1,893.47	1,851.71	2,351.57	18,795.26
530	A-V, RADIO & TV	216.26	118.20	101.05	6.00	91.84	533.35
535	A-V, RADIO & TV SERVICE	379.29	177.43	129.57	10.52	130.13	826.93
550	DEMO. FACILITIES	31.61	34.55	29.54	1.75	26.85	124.29
570	ANIMAL QUARTERS	72.53	39.64	33.89	2.01	30.80	178.88
610	ASSEMBLY FACILITIES	993.47	2,171.93	742.75	165.27	632.86	4,706.28
611	ASSEMBLY SEATING & AISLES	3,487.04	6,701.67	2,196.67	351.19	2,411.91	15,148.48
612	ASSEMBLY STAGE, ETC.	2,234.80	3,860.42	1,141.93	211.26	1,277.03	8,725.44
615	ASSEMBLY SERVICE, ETC.	227.41	744.46	279.53	45.14	280.33	1,576.86
620	EXHIBIT & MUSEUM	666.08	1,456.19	497.99	110.81	424.31	3,155.38
625	EXH. & MUSEUM FAC. SERV.	192.14	840.11	287.30	63.93	244.79	1,628.28
630	FOOD SERVICE	0.00	12,109.52	12,463.13	3,916.42	8,510.16	36,999.23
640	STU. HEALTH SERVICE	0.00	1,569.48	357.82	53.08	813.01	2,793.40
650	LOUNGE	8,678.68	9,977.24	5,883.48	3,259.01	5,298.58	33,096.99
660	MERCHANDISING FACILITIES	2,662.49	2,159.01	2,556.54	320.38	1,507.62	9,206.06

Room Type Code	Room Description	Clean Cost	Heat Cost	Elec. Cost	Water Cost	Maint. Cost	Impact Weighted Total Cost
670	RECREATION FACILITIES	3,955.23	3,919.20	3,085.44	1,456.39	2,415.09	14,831.35
710	DP/COMPUTER FACILITIES	799.83	327.86	597.98	44.35	339.67	2,109.70
715	DP/COMP. FAC. SERVICES	26.62	43.64	79.80	5.90	45.21	200.98
720	SHOP	0.00	470.15	2,807.46	71.35	3,257.00	6,605.97
725	SHOP SERVICE	0.00	123.38	289.79	44.94	330.77	788.89
730	STORAGE & SUPPLY	0.00	5,238.83	2,344.21	1,539.06	2,965.16	12,087.26
740	VEHICLE STORAGE	0.00	0.00	1,126.19	0.00	1,317.58	2,443.78
750	CENTRAL FOOD STOR. & PREP	0.00	835.75	506.51	120.57	523.36	1,986.18
760	CENTRAL LAUNDRY	0.00	774.10	556.97	240.52	473.27	2,044.87
911	STUDENT RES. ROOM	0.00	48,144.42	17,438.41	27,375.69	26,922.38	119,880.89
915	RESIDENTIAL SERV. (CENTRAL)	0.00	4,096.82	1,668.18	1,996.37	2,200.54	9,961.91
916	LIVING ROOM STUDY	0.00	5,126.41	1,693.02	2,866.95	2,658.12	12,344.51
917	KITCHEN	0.00	814.24	234.13	356.96	359.31	1,764.65
918	TOILET/WASH PRIVATE SERV.	0.00	5,655.80	2,050.47	3,280.09	3,143.19	14,129.54
919	OTHER SERV. STOR. ETC.	0.00	1,482.11	500.54	745.71	738.98	3,467.33
922	ONE FAMILY DWELLING—STAFF	3,520.38	1,937.99	378.71	375.69	1,495.05	7,707.82
933	MULTI FAMILY DWELLING—ADV	0.00	3,962.85	774.41	0.00	2,495.42	7,232.67
934	MULTI FAM. DWELLING—GUEST	0.00	0.00	0.00	0.00	217.03	217.03
		253,771.00	437,542.00	219,280.00	105,186.00	221,778.00	1,237,557.00

Exhibit 4.9 (continued)

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IMPACT-WEIGHTED COST BY SUBJECT

Exhibit 4.10

Denison University

Subject Code	Subject Description	Clean Cost	Heat Cost	Elec. Cost	Water Cost	Maint. Cost	Impact Weighted Total Cost
401	BIOLOGY/GENERAL	10,127.82	5,155.00	1,432.83	1,225.23	3,102.14	21,043.03
701	COMPUTER/INFO/SCI	24.45	40.10	73.13	5.42	41.54	184.65
801	EDUCATION/GENERAL	911.85	967.49	923.09	57.45	777.41	3,637.30
835	PHYS. ED.	19,294.22	57,279.76	13,891.61	3,829.01	14,906.75	109,201.36
919	ENGINEERING PHYSICS	0.00	0.00	0.00	0.00	0.00	0.00
1001	FINE ARTS, GENERAL	3,316.76	3,004.72	1,929.30	339.15	1,583.78	10,173.71
1002	ART (PAINTING, ETC.)	4,376.60	2,771.73	541.64	321.40	1,230.68	9,242.06
1003	ART HISTORY & APPREC.	1,252.31	2,737.82	936.28	208.34	797.75	5,932.50
1004	MUSIC (PERFORMING, ETC.)	1,400.03	3,498.65	1,196.46	266.23	1,019.45	7,380.83
1005	MUSIC (LIB. ARTS PROG.)	638.80	634.72	320.14	28.78	297.57	1,920.01
1007	DRAMATIC ARTS	8,774.87	9,462.17	3,023.25	396.01	4,281.96	25,938.26
1008	DANCE	2,548.54	2,887.88	526.72	187.22	1,134.60	7,284.97
1101	FOREIGN LANG., GEN.	2,215.13	1,745.37	2,574.45	228.89	1,586.89	8,350.74
1103	GERMAN	138.07	113.20	206.46	15.31	117.28	590.32
1502	LIT., ENGLISH	1,827.70	1,536.20	2,801.87	207.82	1,591.55	7,965.14
1504	CLASSICS	287.13	313.86	268.33	15.92	243.88	1,129.12
1506	SPEECH & DEBATE	1,058.51	1,057.32	882.73	64.13	789.42	3,852.12
1509	PHILOSOPHY	726.83	737.01	609.67	39.41	562.36	2,675.28
1510	RELIGIOUS STUDIES	999.12	1,059.14	1,023.98	88.87	794.65	3,965.74
1701	MATH., GENERAL	2,054.90	1,613.94	1,888.23	158.04	1,349.37	7,064.49
1702	STATISTICS	79.85	54.55	29.85	4.43	33.91	202.59
1902	PHYSICS, GENERAL	3,564.53	2,098.05	1,209.28	172.89	1,324.08	8,368.83
1905	CHEM., GENERAL	10,079.98	20,926.42	7,156.40	3,184.84	6,504.12	47,851.76
1911	ASTRONOMY	774.21	0.00	408.25	12.11	185.52	1,380.10
1914	GEOLOGY	2,980.46	1,459.29	798.47	118.45	907.12	6,263.79
2001	PSYCH., GENERAL	10,443.20	7,143.36	5,001.18	438.11	5,163.93	28,189.78
2004	PSYCH., COUNSELING	0.00	0.00	0.00	0.00	0.00	0.00
2006	PSYCHOMETRICS	0.00	0.00	0.00	0.00	0.00	0.00
2007	STATISTICS, PSYCH.	0.00	0.00	0.00	0.00	0.00	0.00
2204	ECONOMICS	1,292.37	1,441.28	1,232.22	73.12	1,119.91	5,158.90
2205	HISTORY	980.79	908.58	1,657.14	122.91	941.31	4,610.73
2206	GEOGRAPHY	79.18	54.10	29.60	4.39	33.63	200.90
2207	POL. SCI. & GOVT.	789.72	846.29	723.54	42.93	857.59	3,060.07
2208	SOCIOLOGY	698.49	752.10	643.01	38.15	584.40	2,716.15
2211	AFRO-AM STUDIES	96.82	119.06	144.77	18.79	82.23	461.67
4901	GEN. LIB. ARTS & SCI.	67.87	83.47	101.49	13.17	57.85	323.85
9999	MULTI-DISCIPLINE	6,372.55	5,809.59	5,983.94	1,342.22	4,305.70	23,814.00
0	NO SUBJECT	153,497.31	299,229.76	159,110.70	91,916.82	163,667.88	867,422.48
		253,771.00	437,542.00	219,280.00	105,186.00	221,778.00	1,237,557.00

COMPARISON OF IMPACT-WEIGHTED COSTS WITH TRADITIONAL ASSIGNED SQUARE FOOT COST BY BUILDING

Denison University

Bldg. Code	Bldg. Description	Impact Weighted Total Cost	Assigned SQFT Cost	Difference	Percent Dif.
0047	NEW PHYSICAL PLANT	9,825.	35,134.	- 25,308.	- 257.57
0044	WAREHOUSE	549.	14,373.	- 13,823.	- 2,516.19
0009	MONOMOY	2,504.	15,729.	- 13,225.	- 528.16
0040	SHORNEY HALL	42,563.	51,783.	- 9,220.	- 21.66
0001	STONE HALL	14,933.	23,955.	- 9,021.	- 60.41
0012	DOANE ADMINISTRATION	20,590.	28,030.	- 7,439.	- 36.13
0051	DELTA CHI	2,144.	9,582.	- 7,437.	- 346.79
0027	SHAW HALL	20,352.	27,767.	- 7,414.	- 36.43
0006	MIDDLETON	1,037.	7,819.	- 6,781.	- 653.52
0028	BEAVER HALL	17,059.	23,518.	- 6,458.	- 37.86
0029	SAWYER HALL	17,089.	23,518.	- 6,429.	- 37.62
0035	HEATING PLANT	1,488.	7,787.	- 6,298.	- 423.24
0019	LIFE SCIENCE	31,783.	38,059.	- 6,276.	- 19.75
0017	CURTIS WEST	18,532.	24,366.	- 5,833.	- 31.48
0013	BARNEY SCIENCE	23,555.	28,711.	- 5,156.	- 21.89
0036	WHISLER HOUSE	6,853.	11,881.	- 5,028.	- 73.37
0026	EAST HALL	21,971.	26,340.	- 4,368.	- 19.88
0043	QUONSET HUT	636.	4,340.	- 3,704.	- 582.09
0024	COLWELL	10,247.	13,723.	- 3,476.	- 33.92
0022	CHAPEL	20,155.	23,312.	- 3,157.	- 15.66
0002	KING HALL	9,765.	12,904.	- 3,138.	- 32.14
0048	PRESIDENTS NEW HOUSE	3,125.	6,052.	- 2,926.	- 93.63
0049	ART DEPT. ANNEX	2,221.	5,102.	- 2,880.	- 129.71
0031	STADIUM	21,986.	24,840.	- 2,853.	- 12.98
0011	CLEVELAND HALL	24,815.	27,418.	- 2,602.	- 10.49
0034	CARPENTER	346.	2,779.	- 2,433.	- 701.52
0025	GILPATRICK	3,964.	6,055.	- 2,091.	- 52.75
0018	SMITH HALL	24,681.	26,734.	- 2,052.	- 8.32
0021	BETH EDEN	5,681.	7,084.	- 1,402.	- 24.69
0016	CURTIS EAST	24,897.	26,157.	- 1,259.	- 5.06
0053	CINEMA ANNEX	2,302.	3,265.	- 962.	- 41.81
0050	ATO DORM	13,440.	14,158.	- 717.	- 5.34
0045	WOMENS FIELD HOUSE	169.	884.	- 715.	- 421.28
0046	MONOMOY COTTAGE	2,142.	2,855.	- 712.	- 33.26
0032	LAMSON LODGE	429.	1,091.	- 662.	- 154.34
0039	HUFFMAN HALL	50,513.	51,151.	- 637.	- 1.26
0014	LIBRARY	27,362.	27,839.	- 477.	- 1.74
0023	OBSERVATORY	2,009.	2,324.	- 315.	- 15.68
A014	LIBRARY ADDITION	30,337.	29,315.	1,022.	3.37
0052	DOANE DANCE	9,613.	8,086.	1,527.	15.89
0042	SHEPARDSON HALL	42,785.	40,591.	2,194.	5.13
0008	THEATRE ART	27,247.	23,184.	4,063.	14.91
0038	CRAWFORD HALL	62,662.	57,484.	5,177.	8.26
A017	CURTIS WEST ADDITION	43,562.	35,771.	7,790.	17.88
A030	SWIMMING POOL	28,747.	18,187.	10,560.	36.73
0037	BURKE HALL	45,573.	33,866.	11,706.	25.69
0020	KNAPP HALL	88,891.	73,816.	15,074.	16.96
0033	FELLOWS HALL	68,419.	49,596.	18,822.	27.51
0010	SLAYTER HALL	76,315.	53,332.	22,983.	30.12
0015	CHEMISTRY BLDG.	88,698.	47,902.	40,795.	45.99
0030	FIELD HOUSE	120,968.	77,983.	42,985.	35.53
		1,237,556.	1,237,556.		

Exhibit 4.11

five • drake: instructional capacity

Drake University is an independent institution in Des Moines, Iowa. The enrollment is limited to approximately 5,000 students. Eight colleges and schools comprise the university. Over the last few years, the enrollment pattern among the different colleges and schools has been uneven. For example, more students are enrolling in the College of Business Administration while fewer are enrolling in the College of Fine Arts. In addition, the number of potential students is decreasing so that Drake may face declining overall enrollment or, at best, stabilized overall enrollment during the 1980s. Therefore, to maintain its existing educational programs and to allow for a certain amount of educational innovation, steps are necessary to insure that existing resources are used to their maximum extent.

The vice president for academic affairs and the director of administrative systems at Drake were interested in the ways that improved planning could help the university adapt to changing enrollments. An extensive effort to collect data about course enrollments had been underway at Drake for about five years, and administrators felt that the data could provide input to analyze the cost behavior of the capacity of various academic departments and programs at Drake. Ultimately, the analysis would benefit both short- and long-term planning.

An initial analysis of data for the departments and programs at Drake revealed that expenditures for faculty were fairly independent of the number of students being served. The short-run cost for faculty is more a factor of the number of part-time faculty and the number on sabbatical.

Administrators felt, however, that capacity and utilization of a course could be used as another measure of cost. A course where the number of enrolled students is much less than capacity (underutilized) represents an inefficient allocation of resources. Similarly, a course where enrollment is larger than capacity (overutilized) also strains its resources and may not achieve its objectives. An analysis of capacity, therefore, could identify departments and programs that had either too few or too many students; it could also be used to evaluate each course within a department. The analysts combined figures for maximum enrollment and projected enrollment in a formula that provided a good initial estimate of capacity. Deans and departmental chairmen then reviewed the values for accuracy.

Step 1. Determine Policy Questions and Identify the Management Level Served by the Study

This study was initiated in the office of the vice president for academic administration at Drake with the intent of focusing on management decisions that would affect the instructional function, either for the entire university or within an individual college or department. Deans and department heads and the vice president for academic affairs were expected to be the primary users of the information.

The study had several broad desired results:

1. An analysis of the instructional costs of departments and programs at Drake to identify the degree to which these costs vary with changes in enrollment.
2. An evaluation of the concept of instructional capacity at Drake to determine whether realistic values for capacity could be estimated from the available data and to determine the acceptance and use of this concept among various deans and administrators.
3. A measurement of the unused instructional capacity at Drake and an identification of the departments and programs that had the greatest and the least unused instructional capacity.
4. An investigation of the use of cost and capacity data in estimating the cost to the university of increasing or decreasing enrollments in selected fields of study.
5. A determination of the usefulness of capacity and cost data in managing the instruction function in a college or department.

It was also hoped that the study would answer some specific questions: How many faculty are required to meet the demand in different departments? What curriculum changes are appropriate to use existing resources to the utmost? What student recruitment policies would best serve the overall needs and resources of the university?

Step 2. For Each Function Under Study, Identify the Activities, Activity Measures, and Factors That Affect Costs

The most basic level of analysis for the instructional function is the individual section of a course. Most of the instruction at a university occurs at this level, and for this study, other forms of instruction such as independent study and laboratory sections were excluded. The section level, however, is too detailed for many types of analysis, and it is often desirable to aggregate the data to the level of a course, a department, or a college. If the questions being studied deal with student majors, then a focus on programs is more appropriate; this can be accomplished by dividing the students in each section into their respective majors and then sorting and aggregating the majors so that data about program level result. Drake has grouped similar majors and departments into planning-center majors (PC-majors) and planning-center departments (PC-departments). Planning centers were therefore used as the level of detail for all program and departmental aggregations in this study.

The higher the level of aggregation, the fewer data elements needed to represent all the units. Data for eight semesters were available (fall 1975 through spring 1979, summers excluded), and when each section taught over the eight

semesters is included, there are 7,690 data records. When multiple sections of a course are combined, there are only 5,322 records. This reduction is not large because most of the courses at Drake are single-section courses. In fact, 77% (4,077 out of 5,322) of the courses offered during the last eight semesters at Drake were single-section courses.

The biggest reduction of data occurs at the level of PC-departments and PC-majors because there are currently only 46 PC-departments and 69 PC-majors at Drake. For PC-departments there are 331 records, for PC-majors 524. To aggregate data to the level of a college would give up too much information for an analysis to be useful.

The most common measures of activity for the instructional function are the number of student credit hours (SCHs) and the number of students (headcount). When headcount is used, the time during the semester when students are counted becomes important. Two common times are midway into a semester (when the number of students enrolled is known) and at the end of a semester (when the number of students who receive credit is known). Both of these measures could be used at Drake for each section, and both can be easily summed to a course, a department, or a program. Student credit hours and the census enrollment were chosen because each measure is useful for a different analysis: SCHs for analyses of expenditures for instruction and headcount for analyses of instructional capacity.

An estimate of capacity for each section was also required so that a value for excess capacity (instructional capacity minus enrollment) could be computed. The estimation of this value became one of the most important outcomes of this study.

The initial attempt to compute capacity for each section used two data elements that had been collected from the deans or department chairmen for the eight semesters: maximum enrollment and projected enrollment. It was hoped that a standard formula could be developed using these data elements, but there were no detailed definitions of the two elements that could be consistently applied, and the interpretation of the values differed from department to department and from person to person.

Maximum enrollment has approximately the same meaning as instructional capacity: the number of students beyond which either a new section would be added to accommodate additional students or no additional students would be admitted. Some courses have a practical upper limit on size—for example, a maximum number of seats in a classroom or stations in a laboratory, a limit on the number of graduate assistants available, or a limit on the number of students that a faculty member can effectively teach. In other courses, quality limits the size—for example, a consensus that only a given number of students can be taught before the quality goes below an acceptable level, or an upper level imposed by an accreditation agency.

Projected enrollment was also evaluated as a potential estimate of capacity, but it is more often a realistic estimate of the number of students expected rather than of the number a faculty member would be able to teach.

The algorithm used to estimate capacity took maximum enrollment as the basic value of capacity but reduced this estimate whenever projected enrollment was lower than the maximum value by more than a given amount. When the projected value was 20 or less, capacity was computed as the lesser of the

maximum value or of the projected value plus five. When the projected value was 20 or more, capacity was computed as the lesser of the maximum value or of 125% of the projected value (see Exhibit 5.1). The values used to compute this interval (either 5 or 25%, depending on the projected value) were chosen arbitrarily, based on a visual examination of the data and an effort to remove extreme values.

The review of this formula and of the estimated capacity values revealed that the formula was too conservative. The maximum enrollment figure by itself was a fairly good estimate of capacity; if some adjustment were necessary for very high maximum enrollment figures, then an interval over projected enrollment of 10 or 50% would be better. The numbers reported in this study are based on the initial estimate of capacity, so that all values of excess capacity, if anything, understate true conditions.

Section capacity values cannot be aggregated to departmental or program levels as easily as can SCH or headcount. It is possible to add section capacity values to arrive at a total capacity for a department, but the distribution of capacity among the different sections determines what the real departmental capacity is. A department's capacity should represent its ability to enroll students in its various courses. For example, a department offering a total of 20 courses, each with a capacity of 25 students, is very different from a department offering two courses that have a capacity of 200 each and 30 courses with a capacity of 10 each. The second department may be able to enroll many additional students in its large general introductory courses but may be unable to support many additional majors, while the first department may be able to accommodate additional students in any of its sections, depending on current enrollment levels.

The aggregation to a program level is even more difficult, because capacity relates to a section and SCH or headcount aggregations for programs are based on the number of students of each major within a section. A capacity measure for a program should reflect the typical capacity values for the sections commonly taken by students with that major.

Step 3. Determine Current Levels of Service for Each Activity and Assign Costs to Each Activity

Values for instructional expenditures were directly available from the data. A percentage of a faculty member's salary is assigned to each section taught for credit. The time spent on administrative duties is not included, so that only the percentage of total salary devoted to teaching is allocated. The percentage is proportionate to the number of credits earned by a typical student in each section taught. All costs were adjusted to 1978–79 constant dollars. (See Exhibit 5.2 for a discussion of expenditures for faculty at Drake.)

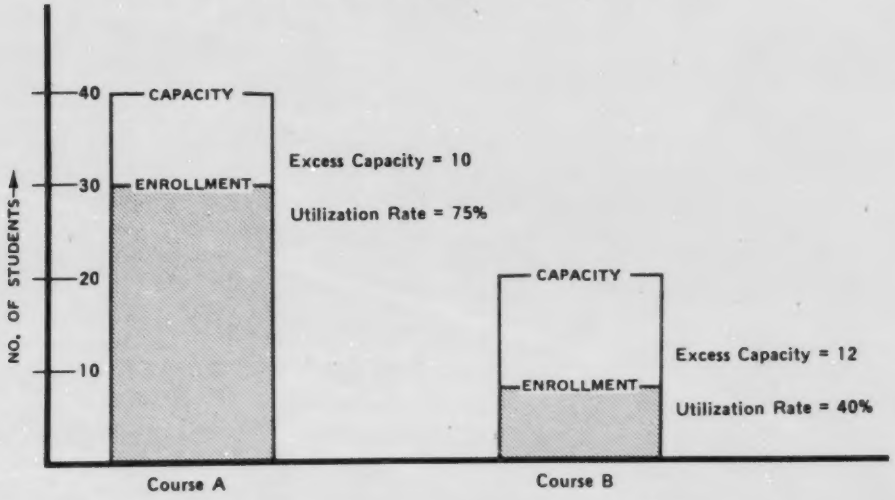
A measure of utilization as a proxy for cost is a nontypical approach, but it makes sense if one considers the revenue lost because of empty spaces in a classroom. Courses that are enrolled near capacity are clearly more profitable than ones that are nearly empty. Measures of utilization can also be very useful as management aids when preparing budgets or evaluating curricula.

Two measures of utilization that were considered were excess capacity (the difference between capacity and enrollment) and utilization (the ratio of enrollment to capacity.) Figure 1 shows these measures for some sample sections. It

is possible to get negative numbers for excess capacity and utilization rates greater than 1. When this occurs, a course's enrollment would have exceeded its capacity, which means either that the department is unable to add an additional section or that the estimate of capacity is below the actual capacity value being used by the department.

Figure 1

EXAMPLES OF UNUSED CAPACITY MEASURES



These formulas can be easily applied to data for sections, but there is some question about how to aggregate excess capacity for courses or departments. It is also not clear how to compute capacity for a program because each course is usually taken by students from several different majors. A simple solution, for use with the course and department files, is simply to apply the calculation for excess capacity or utilization rate to the totaled values for capacity and enrollment in each record of the aggregated file. For example, a department may have a total capacity of 400 students and a total enrollment of 350, resulting in an excess capacity of 50 and a utilization rate of 88%. If 20 sections were offered, then the average excess capacity per section would be 2.50 and the average utilization rate would still be 88%.

This approach, however, seems to lose some important information. For example, two possible department profiles are shown in Table 4. Both departments have the same total value for capacity, enrollment, and excess capacity, but the distribution of enrollment is quite different. In department A, three classes are full and one class has 40 empty spaces, while in department B, the enrollment is evenly distributed in that all four classes have 10 extra spaces. Department B is more likely to be able to accommodate extra students than is department A.

To capture this type of information, a formula to compute a weighted average excess capacity was developed. The formula uses student credit hours as the weighting factor:

$$\text{Weighted Excess Capacity} = \frac{\Sigma\,(SCH_i \times \text{Excess Cap}_i)}{\Sigma \times SCH_i}$$

where i represents each individual section. For example, if each of the courses in Table 4 were offered for equal credit, the weighted excess capacity for department A would be 2.50 and the weighted excess capacity for department B would be 10.00. These values correspond to the idea that department A has less excess capacity than department B.

Table 4
Possible Distributions of Excess Capacity for a Department

	Course Number	Capacity	Enrollment	Excess Capacity
Department A	1	50	50	0
	2	50	50	0
	3	50	50	0
	4	50	10	40
	TOTAL	200	160	40
Department B	1	50	40	10
	2	50	40	10
	3	50	40	10
	4	50	40	10
	TOTAL	200	160	40

Step 4. Determine the Behavior of Costs for Each Activity

One of the objectives of this study was to identify the degree to which costs for faculty within departments and programs at Drake vary with changes in enrollment. It was fairly easy to investigate this relationship since information on total expenditures and student credit hours was available for PC-departments and PC-majors for all eight semesters. Marginal costs can then be estimated in a straightforward manner because one way to estimate marginal costs is to compute the slope of a line fitted by linear regression through observations differing by volume and cost (see Figure 2). This method provides a good estimate of marginal costs as long as the increase in cost of one additional unit remains fairly constant over the range of volume used.

This definition of marginal cost is very similar to that of variable cost, but the distinction is important. Variable cost for any discrete observation is the portion of total cost that varies directly with volume (SCHs in this case). Marginal cost is the increase in total cost attributable to one more unit of production or service (also SCHs in this case). Marginal cost measures the rate of change of the total cost function, while variable cost measures the variable portion of total cost for a particular volume.

For example, in Figure 2, at 10,000 SCHs, the total cost is approximately $600,000 divided evenly between variable cost ($300,000) and fixed cost ($300,000). The average cost is the total cost divided by the total number of SCHs ($600,000 ÷ 10,000 = $60). Marginal cost can be computed by using the formula $MC = \frac{\triangle TC}{\triangle SCH}$ for two discrete volume levels. Therefore, when comparing total cost and SCH at 1,000 SCH and 8,000 SCH:

$$MC = \frac{\$600,000 - 540,000}{10,000 - 8,000} = \frac{\$60,000}{2,000} = \$30$$

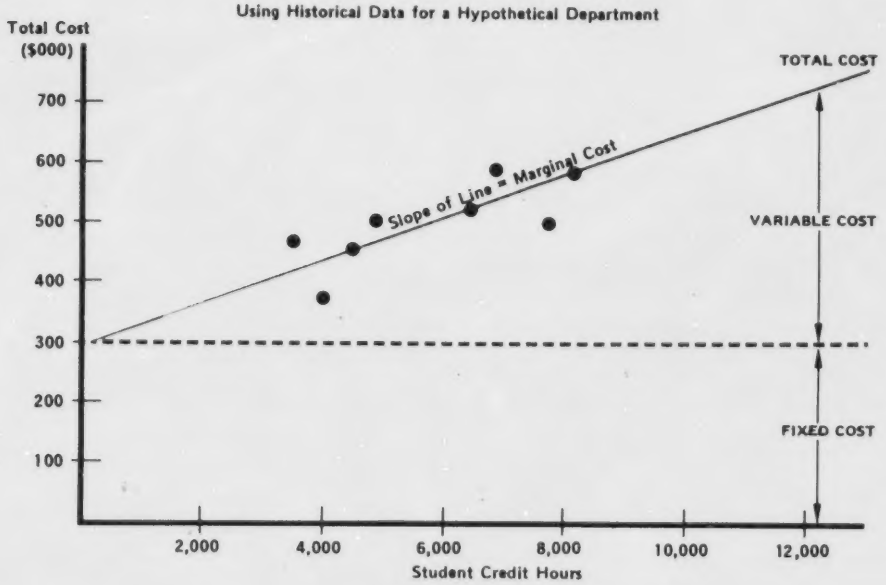
Because linear equations are used, the marginal cost is always a straight line and always produces the same number regardless of which two points are used to measure it. With linear functions marginal cost (MC) always equals average variable cost (AVC).

$$AVC = \frac{VC}{SCH} = \frac{\$300,000}{10,000} = \$30$$

Therefore, for this analysis "average variable cost" could be substituted for marginal cost, although it would not hold true if total costs were measured as a curvilinear function.

Figure 2

EXAMPLE OF MARGINAL COST ESTIMATION
Using Historical Data for a Hypothetical Department



It was felt, however, that this simple method of analyzing costs would prove inadequate for departments and programs as small as those at Drake. Factors other than enrollment were likely to be more important determinants of cost. Therefore, an analysis of excess capacity was used to analyze costs.

Additional data are necessary if the information provided by an estimate of capacity is to be useful. A weighted excess capacity value for a department may indicate where a problem exists, but a detailed examination of the courses in the department is necessary before any action can be taken. One type of report that is useful is an induced course load matrix (ICLM)—a table that lists courses by major and indicates the number of students from each major in each course. Summary reports in the form of histograms were prepared for this study, because the pattern of different majors in a department is difficult to deduce from a detailed ICLM (see Exhibits 5.3 and 5.4). Exhibit 5.3 shows the total number of student credit hours taken from a department by each major and the total number of sections that have students enrolled from each major. Exhibit 5.4 shows the same type of information from the perspective of the program, indicating the number of student credits produced by the students with that major in each department and the number of sections in each department containing students from that major. A dean can use such reports to identify programs or departments that should be examined more fully with the detailed ICLM and to provide a quick summary of the program mix of a department.

Finally, a list of historical data for each section in each department was produced, showing total cost, total SCH, total enrollment, maximum enrollment, projected enrollment, capacity measure, and excess capacity. The list shows all the values for a course over eight semesters so that trends in costs and enrollment can be easily identified. It also provides the detailed excess capacity values that can be used to explain the weighted excess capacity value for a department.

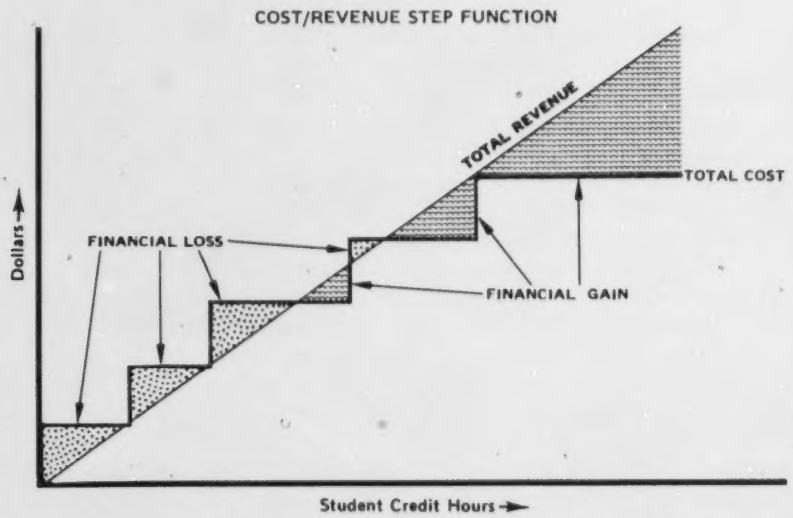
Step 5. Evaluate and Document the Policy Implications of the Study

The cost per section, capacity, excess capacity, ICLM summaries, and course lists can be very useful in considering policy issues dealing with instruction. One natural application is the budgeting process for the university, a college, or a department. If it were necessary to increase or decrease faculty, then knowledge of the teaching demand in the different units would be useful background information.

These types of data would also be useful for the preparation of a departmental budget. More detailed information would be needed. For example, the ICLM data could show how some classes, while possibly under capacity in their enrollment, were still important courses because of the demand placed on them by different programs. Similarly, heavily overutilized courses could be used to justify additional faculty.

Estimated total instructional cost based on the number of students enrolled in various programs could be used to construct a cost function model. This model would make the assumption that, whenever the enrollment in a section exceeds section capacity, a new section would be added at a fixed incremental cost. As long as additional students in a section did not cause the enrollment to exceed capacity, no additional cost would be accrued. The ICLM data would be used to predict the courses that students in each program would take so that predicted changes in enrollment in various programs would correspondingly affect enrollment in different courses throughout the university. The cost function produced by this type of analysis is known as a step function (see Figure 3). Figure 3 also plots total revenue, which would be a straight line, as each additional student credit hour generates an average amount of additional revenue.

Figure 3



A breakeven analysis can be done to determine enrollment levels that generate more revenue than expense.

A cost model of this type could be a useful tool to determine the likely number of additional students that could be accommodated by a particular program. The model would predict the increased revenue from those students, but because no new sections would be required, the cost of instruction should remain the same. This type of information would be a useful tool for planning tuition discounts. If additional students could be recruited into the programs selected by this type of analysis (perhaps by offering student aid or other forms of discount), then overall revenue to the university might increase.

Perhaps most importantly, capacity data are useful for planning curricula. A list of all courses in a department would be prepared, including the section cost, enrollment, and excess capacity values for each section over the last few semesters. ICLM data for each course would indicate which majors are supplying students to the courses. The list could then be analyzed with regard to course consumption, with three questions to be answered: Where can courses be trimmed? Which courses need to be maintained? Where can courses be added?

The regression analysis of cost data versus student credit hours (see Figure 2) did not produce significant results. An examination of the data in Exhibit 5.5, which lists the marginal cost (slope) and fixed cost (intercept) values from each regression for every PC-department at Drake, proves this point. The values in the column labeled "R-Squared" are the values used to determine the accuracy of this model. R-squared values can range between 0 and 1, with values near 1 indicating a very good fit between the model and the data. As the exhibit shows, the results of these regressions at Drake ranged from values very near 0 to values near 1. This type of variation in R-squared values is typical of data that do not conform to a simple linear relationship. As a result, none of the marginal cost or fixed cost values in Exhibit 5.5 are meaningful. None of the other regression analyses performed were any more significant

The conclusion to be drawn from these results is that departmental faculty costs do not respond directly to changes in enrollment, even over several years.

The capacity analysis was much more promising. For example, the ICLM is distributed widely at Drake, and many deans and department heads use it regularly, particularly to review programs and analyze curricula. In the past, however, capacity data were not explicitly identified and as a result decisions using capacity concepts had to be made intuitively. The deans agreed that concrete capacity and excess capacity values, especially for all courses over a period of time, were valuable tools. To be useful, however, the data must be accurate and capacity values must reflect true qualitative decisions regarding ideal class size.

Ranking departments or programs by weighted average excess capacity was a way to verify that the weighted average excess capacity values for departments and programs correspond to actual conditions at Drake. These rankings, shown in Exhibits 5.6 and 5.7, reflect recent enrollment patterns at Drake and are similar to a ranking that would be produced based on the judgment of administrators at Drake.

These capacity estimates have some problems, however. The problems were probably inevitable, mainly because the maximum and projected enrollment values used to estimate capacity had not been used for that purpose in the past. During the first few years these numbers were collected, gross inaccuracies in the numbers reported were common. Recently, estimates have been prepared more carefully, but the intention was simply to allocate rooms more efficiently and to make sure faculty assignments were reasonable. In some cases, maximum enrollment figures were submitted that were much larger than the class size actually desired because recent enrollment demand had been so heavy that the department had decided to increase class size to accommodate additional students. The inflated maximum enrollment figure, therefore, was used to find a classroom large enough to hold the expected number of students. In cases where enrollment had been much lower than previous levels, departments reduced the reported maximum enrollment figures to correspond more closely with expectations, even though more students could easily be taught.

Another problem with the data reports was that the capacity estimates were computed section by section and semester by semester so that a course might have several quite different capacity estimates. Theoretically, the true capacity for a course should be constant, possibly with adjustments made for day versus night sections or for certain select honors sections. These inaccuracies and inconsistencies in the data can be easily corrected once they are identified. Future collections can request specific capacity information, and definitions can be written to encourage consistency. The current data can be reviewed and corrected as appropriate. These efforts will result in reliable data.

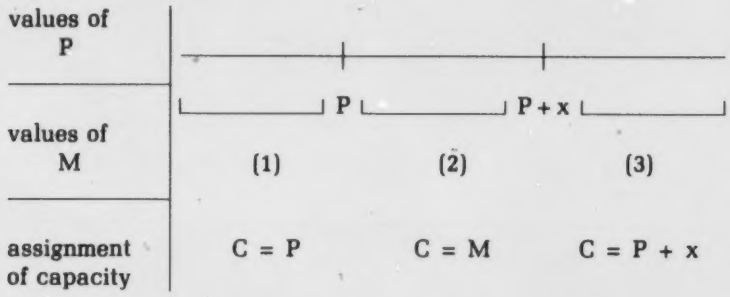
One potential problem in reviewing the data is the possibility that capacity values could be selected for the purpose of improving a department's bargaining position for future budget allocations. The existing data, however, would help to alleviate this problem. The existing capacity estimates based on maximum and projected enrollment, while imperfect, are not too far from true capacity. Any major changes by a department would have to be justified. Thus, changes would be possible, but they would be understood by all concerned. The historical nature of the data would always provide this check for consistency.

Exhibit 5.1

Computation of Capacity for Drake

Each section in the data base has the values M (maximum capacity to be allowed in a course) and P (projected capacity of the course). Neither of these values can be used consistently as a measure of capacity. In some cases, a class is offered in a room that could hold many more students than the department would be willing to teach, so M is higher than actual capacity. In other cases, the projected number of students is less than the department would actually like to teach.

The solution was to apply a general formula to estimate a measure of capacity for each section. The respective departments can then check these estimated capacity values for validity. The basic algorithm can be illustrated by the following figure:



The figure illustrates the possible relationships of M and P to each other. If M falls in interval (1) (a condition where M is reported as less than P), then the M value is assumed to be in error and capacity is set equal to P. If M falls in interval (2) (larger than P but within some interval x), then the M value is treated as a true measure of capacity. If M falls in interval (3), it is interpreted as a room size rather than capacity, and the capacity is set to P plus the interval x. This last assumption is based on the idea that the time capacity is usually slightly more than the projected value.

The most arbitrary part of this algorithm is the calculation of the interval x. In this study, x is computed as the larger value of 5 and 0.25 x P. For example, if $P = 15$, then $x = 5$; if $P = 28$, then $x = 7$ (that is, for $P < 20$, $x = 5$ and for $P \leq 20$, $x = 0.25 * P$). This algorithm was chosen so that reasonable values were picked for both very large and very small sections. The following flowchart shows this computation.

Flowchart of Formula Used to Compute Capacity:

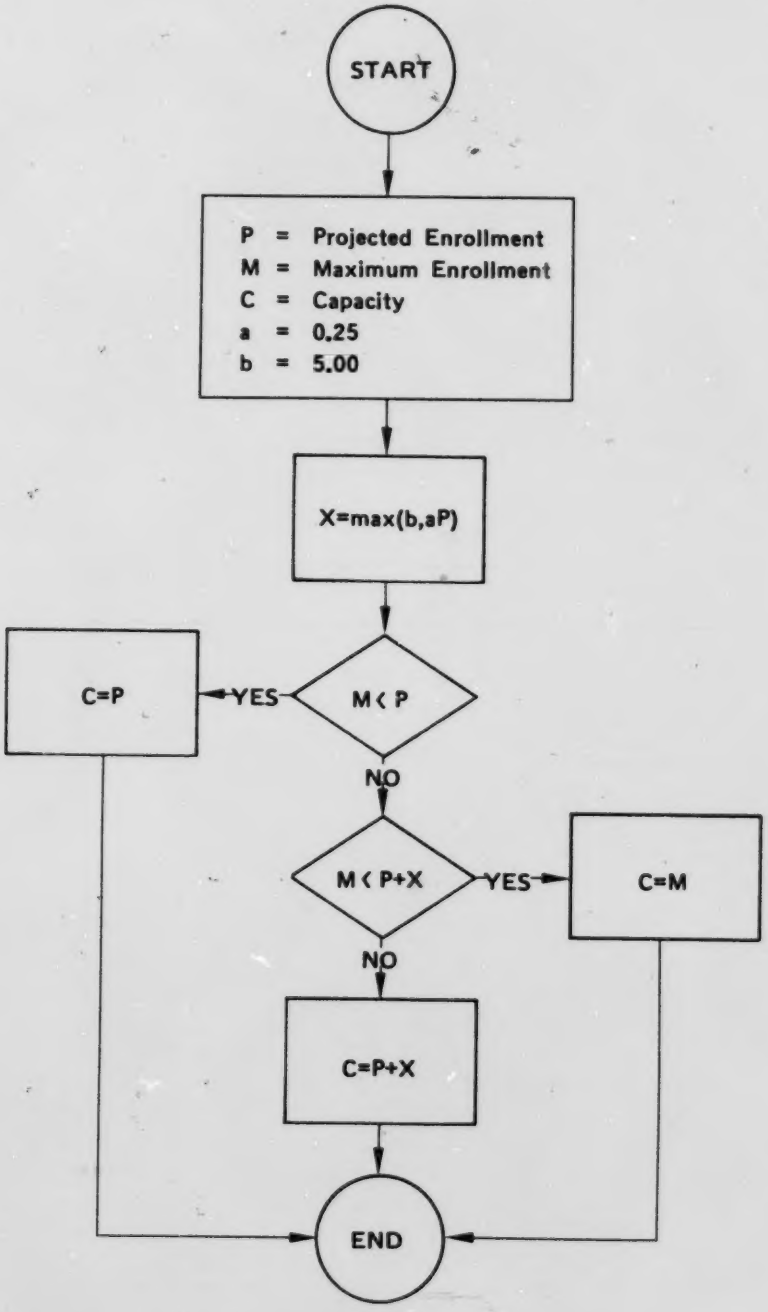


Exhibit 5.2

Cost for Faculty at Drake

The cost of instruction for a section is basically a weighted proportion of the salary of the faculty member teaching that section. This cost is computed by the following steps:

1. An FIH (faculty instruction hour) is computed for each section as: FIH = (mean credit hours) × (section load factor), where *mean credit hours* is the average credits earned per student and *section load factor* is a weighting factor that can vary the load for that course (for example, 1.0 is a normal load).

2. The FIH is computed for each section taught by a faculty member and then summed to compute the total FIH for that faculty member. The cost of an individual FIH for that faculty member therefore equals:

$$\frac{\text{(salary)} \times \text{(percent time spent in instruction)}}{\text{total FIH}}$$

3. The total cost of a section, therefore, equals the previous quantity times the FIH for that section. The complete formula is:

$$\text{total cost} = \begin{matrix}\text{FIH} \\ \text{for} \\ \text{section}\end{matrix} \times \left[\begin{pmatrix}\text{salary of} \\ \text{faculty} \\ \text{member}\end{pmatrix} \times \begin{matrix}\text{percent} \\ \text{time} \\ \text{teaching}\end{matrix} \Big/ \begin{matrix}\text{total FIH} \\ \text{for faculty} \\ \text{member}\end{matrix} \right]$$

The cost per student credit hours in a section can be computed as the total cost divided by the total student credit hours awarded.

Costs were also adjusted according to the average salary increase granted at Drake over the last four years, so that all dollar costs would be represented in 1978–79 dollars. The following table shows these adjustment factors.

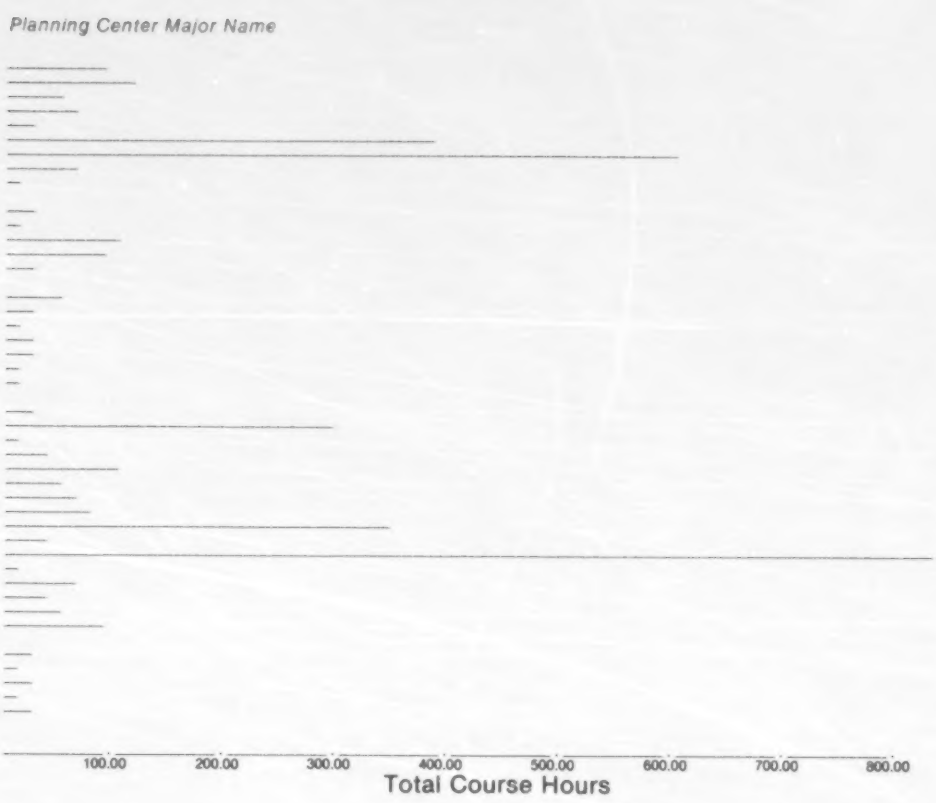
Price Adjustment for Drake Faculty Salaries

Semester[a]	*Percent Increase*[b]	*Adjustment*[c]
Fall 1975 Spring 1976	7	1.1682
Fall 1976 Spring 1977	3	1.1342
Fall 1977 Spring 1978	7	1.0600
Fall 1978 Spring 1979	6	1.0000

[a]Projected increase in FY 1980 is 5%.
[b]Average percent increase in salary from previous year.
[c]Multiplying salaries in each year by this factor adjusts amounts to 1978–79 dollars.

STUDENT CREDIT HOUR CONSUMPTION FOR A SAMPLE DEPARTMENT AND MAJOR

Total Course Hours Taken from a Department by Different Majors



PC-Majors	Planning Center Major Name	Number of Sections	Total SCH
ACCT		9	75.00
ADV/PR		8	112.00
ART		10	38.00
B/OTH		6	55.00
BGS		4	23.00
BIO/P/P		25	373.00
BIOLOGY		34	565.00
CHEM		7	56.00
CIS		4	12.00
COM/SC		1	3.00
EA/SC		6	21.00
ECONOMICS		3	12.00
ED/OTH		10	95.00
EL/ED		5	54.00
ENGLISH		4	22.00
FA/OTH		1	3.00
FIN		8	49.00
G/BUS		3	21.00
GRAPHIC ARTS		5	12.00
H/PE		4	22.00
HISTORY		3	19.00
I/MAJ		4	9.00
INREL		2	11.00
INS		1	3.00
J/OTH		5	18.00
LA/OTH		19	262.00
LAW/E		1	6.00
MAGAZINE		3	29.00
MED/T		11	85.00
MGT		5	35.00
MKTG		8	48.00
NEWS EDITORIAL		7	65.00
NURSE		1	327.00
OTHER		5	28.00
PHARMACY		13	811.00
PHY/AST		2	7.00
POL SCI		6	57.00
PSYCH		6	26.00
PUB/AD		6	37.00
RAD/TV/BRD		5	76.00
RELIGION		2	2.00
RETAILING		4	21.00
SEC/ED		3	10.00
SOCIOLOGY		5	20.00
SPANISH		2	9.00
SPEC ED		2	22.00
SPEECH COMM		1	3.00
UND/U		1	1.00

Exhibit 5.4

STUDENT CREDIT HOUR CONSUMPTION FOR A SAMPLE DEPARTMENT AND MAJOR

Total Course Hours Taken by Students in a Major from Each Department

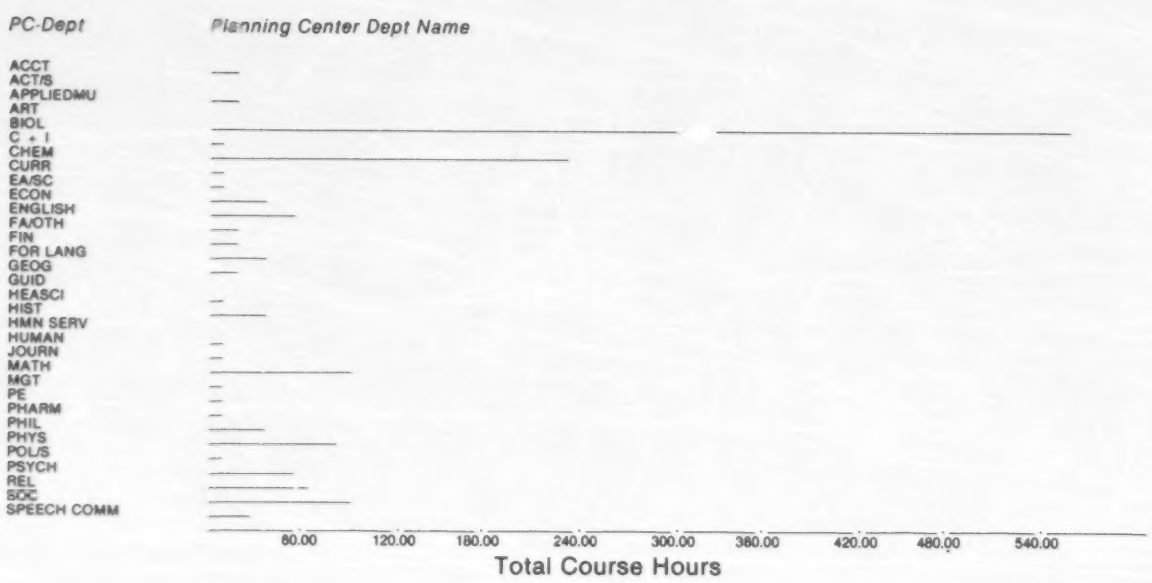


Exhibit 5.5

Marginal Costs Estimates from Regression Analysis of Departmental Data

Department	*Marginal Cost*	*Fixed Cost*	*R-Square*
AD ED	$-1.07	$18,381.00	0.00002
SOC	$-0.70	$111,058.00	0.00030
RECRE	$-2.85	$5,570.00	0.00040
HUMAN	$0.77	$8,737.00	0.00070
ASTR	$-1.50	$4,987.00	0.00100
COM-S	$5.75	$5,493.00	0.00800
PHARM	$-6.99	$151,850.00	0.00900
JOURN	$18.86	$54,233.00	0.01200
PHY-S	$2.07	$12,999.00	0.01700
P-ADM	$-32.30	$62,283.00	0.03400
HIST	$14.51	$49,277.00	0.04000
BIOL	$16.92	$69,226.00	0.06300
PE	$32.37	$27,240.00	0.08200
ACT/S	$40.57	$9,750.00	0.09200
SPEECH COM	$-9.49	$46,975.00	0.10400
ADMIN	$29.70	$8,137.00	0.10800
FIN	$14.77	$30,513.00	0.11900
CHEM	$9.19	$42,818.00	0.13000
MGT	$17.83	$39,297.00	0.13800
EARLY CH	$-12.57	$5,216.00	0.14500
PHIL	$22.03	$8,463.00	0.15100
GEOG	$-16.24	$25,704.00	0.15600
REL	$11.95	$23,703.00	0.15600
C + I	$46.15	$7,119.00	0.16200
THEATRE	$23.16	$27,379.00	0.17300
MKTG	$13.42	$25,977.00	0.17800
MATH	$39.37	$-8,959.00	0.18100
ART	$20.37	$73,672.00	0.22000
PSYCH	$12.79	$53,166.00	0.22000
APPLIEDMU	$48.12	$129,631.00	0.22500
MISC LA	$55.02	$54,606.00	0.25100
ECON	$12.29	$25,246.00	0.26900
PHYS	$-16.05	$48,084.00	0.34400
EA/SC	$35.57	$-231.00	0.36600
READ	$84.43	$-6,114.00	0.38300
POL/S	$-31.64	$114,280.00	0.44800
ACCT	$22.48	$14,058.00	0.46600
FA/OTH	$42.65	$-13,654.00	0.55500
HEASCI	$53.21	$-1,791.00	0.56600
ENGLISH	$55.12	$-57,192.00	0.57200
SPCED	$140.95	$-85,806.00	0.60500
HMN SERV	$21.11	$1,699.00	0.73800
FOR LANG	$66.80	$-1,682.00	0.84700
REHAB	$220.98	$-9,625.00	0.87600
GUID	$482.77	$-135,454.00	0.90000
CURR	$47.74	$19,941.00	0.91700

Exhibit 5.6

Excess Capacity Estimates for Departments at Drake*

PC-Departments	*Weighted Average Excess Capacity*	*Total Excess Capacity*	*Total Excess Capacity Per Course*
RECRE	-6.80	-8	-4.00
EARLY CH	-6.48	-4	-1.33
ECON	-4.96	88	4.00
AD ED	-4.49	-3	-1.50
CURR	-2.78	107	2.74
MISC LA	-2.51	12	2.00
SPEECH COMM	-0.23	5	0.31
MATH	0.31	140	3.68
FIN	0.81	53	2.94
ACCT	0.94	138	3.94
C + I	2.01	26	4.33
ENGLISH	3.15	290	4.60
READ	3.16	37	5.29
MGT	3.16	133	4.29
GUID	3.20	58	4.83
JOURN	3.25	148	3.61
ACT/S	3.35	136	7.16
THEATRE	3.41	78	4.11
HEASCI	3.49	18	4.50
FA/OTH	3.63	131	8.73
MKTG	3.73	57	4.38
SOC	4.38	284	6.60
GEOG	4.91	46	5.11
REHAB	5.21	21	5.25
PHIL	5.34	57	4.75
FOR LANG	5.36	289	6.72
REL	5.49	118	5.90
HMN SERV	6.25	25	6.25
SPCED	6.88	103	8.58
ASTR	7.00	7	7.00
PE	7.18	306	8.05
APPLIEDMU	8.24	592	6.37
ADMIN	8.53	52	8.67
P-ADM	9.31	182	9.58
COM-S	9.89	83	11.86
POL/S	9.93	226	11.89
PHYS	10.26	93	9.30
EA/SC	10.84	63	7.88
ART	11.33	597	11.06
HIST	11.46	277	9.23
PHARM	12.14	209	8.71
PHY-S	14.16	42	14.00
BIOL	22.83	442	11.95
CHEM	24.02	166	12.77
HUMAN	29.35	42	21.00
PSYCH	35.51	388	14.37

*This report is presented only as an example of the type of rankings that could be produced; the data used to prepare the report were not validated, and no significance should be placed on the order of departments shown here.

Excess Capacity Estimates for Programs at Drake* Exhibit 5.7

PC-Major	Number of Sections	Total SCH	Weighted Average Excess Capacity
P/LAW	9	28.0	0.17857
TH/ED	13	38.0	0.44737
CURR	20	111.0	0.78378
MKTG	210	1802.00	1.42730
EL/ED	208	2131.5	1.59184
GUID	43	698.0	1.86246
G/BUS	228	2409.0	1.91366
READING	16	117.0	2.09402
FIN	171	1087.0	2.16605
LAW	26	120.0	2.68333
SOC/SC	22	74.0	2.78378
B/OTH	275	3116.5	2.80106
SEC/ED	119	540.0	3.15556
Q/ANA	5	15.0	3.20000
COM/SC	65	238.0	3.29202
MGT	215	1731.5	3.33728
RETAILING	123	582.0	3.35395
SPEECH COMM	130	775.5	3.43972
ACCT	299	3691.0	3.56624
THEATRE	98	790.0	3.62911
ECONOMICS	139	674.5	3.96071
UND/U	67	485.0	4.14433
H/PE	173	1321.5	4.23042
SPEC ED	97	837.0	4.50418
CHURCH MU	16	39.0	4.64103
OTHER	192	916.5	4.68085
ACT/S	152	1275.0	4.83765
CIS	140	724.0	4.97376
ADMIN	18	129.0	5.08527
ADV/PR	280	2801.0	5.17190
INS	48	153.5	5.20195
RAD/TV/BRD	233	1606.0	5.60772
GRAPHIC ARTS	96	397.0	5.84131
SOCIOLOGY	217	1250.5	5.85526
MATH	72	302.5	5.95537
I/MAJ	67	212.5	5.99059
PHIL	19	58.0	6.00000
HISTORY	135	601.5	6.05736
PUB/AD	180	1368.5	6.15418
ED/OTH	222	1460.5	6.47758
MU/ED	115	977.5	6.51151
BGS	78	293.0	6.54608
APPLIEDMU	161	1329.5	6.55434
POL SCI	234	1549.0	6.70562
SPANISH	55	200.5	7.01995
RELIGION	52	182.0	7.17582
J/OTH	86	391.5	7.18008
ART/ED	80	392.0	7.36480
INREL	66	316.0	7.63291
HUMAN	11	24.0	7.75000
NEWS EDITORIAL	149	1076.0	7.81784
PHY/AST	57	329.0	7.93617
ENGLISH	150	787.0	7.95362
EA/SC	60	233.0	8.10730
FA/OTH	121	439.0	8.16287
MAGAZINE	122	572.0	8.25175
FRENCH	28	98.5	8.6447
PSYCH	170	1139.5	8.6880
LAW/E	34	113.0	9.1150
GERMAN	8	18.0	9.2778
ART	261	3184.5	9.4820
LA/OTH	341	3546.5	10.2598
BIOLOGY	190	1513.0	11.7736
PHARMACY	203	5981.0	13.5681
CHEM	47	231.0	13.6450
MED/T	50	253.0	13.6917
BIO/P/P	148	1075.0	14.9651
NURSE	6	1080.0	42.9444

*This report is presented only as an example of the type of rankings that could be produced; the data used to prepare the report were not validated, and no significance should be placed on the order of programs shown here.

six • santa fe: student services

Santa Fe Community College in Gainesville, Florida, is a public, state-supported, two-year institution. Founded in 1965, the college reached its peak enrollment during the 1974–75 academic year. Although the college provides services to approximately 22,000 students, the number of FTE students is much lower—approximately 6,700. The number of FTE students is significant because state funding is based on a formula that uses FTE for resource allocations. An increase in part-time students has created fiscal problems for the college as it attempts to distribute its reduced resources. Today the level of expenditures for the college is approximately $12 million. Since 1975, with proportionately fewer inflated dollars available to serve more students, the college has been forced to make difficult decisions about expenditures, especially those for support services. The vice president of administration agreed to participate in this study to develop a better way of estimating how costs change in relation to student enrollments.

The study's primary objectives were the following:

1. To examine the college's student services function to determine how the services it is providing vary for each student program.
2. To estimate to what extent the costs of student services are fixed, given the level of service described above.
3. To estimate how resource requirements vary for student services as the result of changes in enrollment.
4. To estimate to what extent the costs of student services can be changed as the result of changes in administrative policy.

The college was founded with an exceptional commitment to serving students. In its early years, 34 individuals who divided their time between counseling and teaching were available to advise and counsel students on academic and personal matters. The college's costs for student services rank in the upper quarter of Florida's 28 two-year institutions. In 1977–78, the costs were $158,000, for a behavioral science course that is taken by more than 50% of entering first-year students; this represents 23% of the total student services cost and 70% of the counseling and advisement costs.

The college recently reassigned 33 of the 34 counselors to full-time classroom duties, deemphasizing the commitment to personal and career counseling, and employed paraprofessionals to serve as academic advisors. Career guidance is furnished primarily through a computerized system known as SIGI

(System of Interactive Guidance and Information). By restructuring student service activities, the college has reduced staff and budget allocations.

Student Programs and Student Services

The college serves students through a number of different credit and noncredit programs. Credit programs include (1) advanced and professional (A&P), which is for students studying for an Associate degree, often planning to transfer to a four-year institution; (2) occupational, which prepares students for entry-level employment and is for students studying for an Associate in Science degree; and (3) high school, which offers eleventh and twelfth grade students an opportunity to enroll in a vocational program at the college. Noncredit programs include (1) occupational, which is offered to part-time students wishing to broaden their knowledge about their current field; and (2) community instructional service (CIS), which offers recreational and vocational courses.

Student services can be one of three types: (1) counseling and advisement (including academic advisement, career counseling, and personal counseling); (2) financial aid administration (including financial counseling and forms processing); and (3) records and admissions (including admissions, and registration and records maintenance).

Exhibit 6.1 shows the distribution among student services for expenditures and staffing for 1977–78, the base period used for the cost behavior analysis. Actual expenditures and personnel analyses were used for this study because they were easily available and because the college has excellent records. However, other data sources, such as budgeted costs, could have been used. The use of average capital and operating costs for three or four years might have improved the results of the analysis by evening out unusual expenditures that may have occurred in any one year, but the additional analysis was deemed unwarranted for this study.

Step 1. Determine Policy Questions and Identify the Management Level Served by the Study

The study was intended to provide the vice president of the college with a more systematic evaluation of student services and how they are affected by changes in enrollment. The vice president needed to better understand why the program was costly and what services it was providing to what types of students.

Step 2. For Each Function Under Study, Identify the Activities, Activity Measures, and Factors That Affect Costs

Each of the three activities (counseling and advisement, financial aid administration, and records and admissions) is self-contained, with its own budget and organizational responsibility. The fall term enrollment was the activity measure used for the study. Student headcount numbers were used instead of FTEs because student services are generally a function of individuals rather than the total of full- and part-time students and because approximately the

same amount of effort is required to provide services to an individual, regardless of his or her status as a full- or part-time student.

The student headcounts were classified by type of student program. For this study, it was important to track enrollments for each student program because some student programs (advanced and professional, for example) require substantially higher service levels than others (such as high school).

Step 3. Determine Current Levels of Service For Each Activity and Assign Costs to Each Activity

Levels of service for each activity were based on a combination of empirical analysis and subjective judgment. A weighted factor was assigned to each student program and was used to estimate the extent to which a student program uses a student service. The standard level of service for each student service was assigned a value of **1**. The two primary credit programs, A&P and occupational, have weights of **1** assigned to all student services because students in those programs use the full range of services offered. Each of the other student programs requires significantly less student service support. Exhibit 6.2 shows all weights assigned to the programs.

The table in Exhibit 6.2 has two significant uses. First, the impact on student services resulting from changes in student enrollment can be measured. Because the student programs use the student services in varying degrees, enrollment shifts in different student programs will not have the same impact on student services.

Second, changes in the quality of services or their method of delivery can be examined. When a weighted value changes, it in effect redistributes the existing amount of resources being spent on student services. For example, if one wishes to decrease the level of academic advisement, the weight of **1** can be reduced accordingly and the reduction in resources estimated.

Weighted values were determined as follows:

Advanced and professional program. Students in this program require the maximum level in all student services, and accordingly all requirements have been assigned weights of **1**. No other student programs require greater effort or use than this program.

Occupational (credit). The level of service is similar to that required for the A&P program, and all weights were accordingly set at **1.**

High school. Students in this program require fewer services than the other credit programs. Career counseling and personal counseling were given a weighted factor of **0.7** because high school students do not enroll in the behavioral science course that accounts for a large part of costs. The high school students receive no financial aid; hence, a value of **0** was given to financial aid administration. Finally, minimal recordkeeping is required for high school students, and consequently weights of **0.5** were assigned to both admissions and to registration and records maintenance.

Occupational (noncredit). Students in this program require minimal student services; weights range from **0** to **0.5**.

Community instructional services. CIS students require even fewer services. Only in records and admissions do they require any service; a weighted factor of **0.2** was assigned to admissions and to registration and records maintenance.

To assign costs for each activity, the data shown in Exhibit 6.3 for 1977–78 were used. Expenditures used in the analysis were divided further by object of expenditure so that costs for professional and support staff as well as operating and capital expenditures could be measured.

The expenditures used in this study excluded programs involving federal grants and contracts because such expenditures are generally for incremental, innovative, or experimental programs that would not be undertaken if the project funds did not exist.

Step 4. Determine the Behavior of Costs for Each Activity

Each of the student services was examined to determine how costs varied in relationship to a change in volume and which costs were fixed and which were variable, depending on enrollments. Another important factor that must be determined is the relevant range of student enrollments to be studied. For example, the college's enrollment level is approximately 11,000. The methodology used in this study can only reasonably estimate the impact of changes of approximately ± 10%, or a range of 9,900 to 12,100 students. Enrollments outside this range may cause such a change in services that the data would prove inadequate. The same range must be applied to each of the student programs. For example, for the study to be useful, A&P enrollments should be within ± 10% of 3,900 students.

The following discussion describes how costs of student services were designated as fixed or variable.

Counseling and Advisement. Costs for academic advisement, which involves assisting students to schedule courses and advising them about academic goals, are entirely variable, depending on changes in enrollment. Counselors' time is devoted only partly to advising; the majority of their time is spent in other college duties, and therefore their function depends on numbers of students enrolled.

Career counseling is similar to academic advisement. The amount of resources required varies directly with the number of students using the service. For this study, it was assumed that the proportion of students seeking career counseling did not vary materially as enrollments changed, and it was therefore decided that career counseling should be allowed to vary directly with student headcounts. The administrative staff that oversees these areas includes a part-time administrator and clerical support staff. These individuals do not have direct contact with students, so there is less correlation between the level of service they provide and headcount enrollment. It was assumed that administrative and clerical support would be required at essentially the same level regardless of the specific activity level of each service. Therefore, administrative and clerical costs were assumed to be fixed.

Costs for counseling and advisement, divided into their fixed and variable components, are shown in Exhibit 6.4.

Financial Aid Administration. Because the financial counseling service aids students seeking financial aid, a close correlation exists between the required level of service and the number of students seeking financial aid. It has been assumed for this study that student headcount enrollments is a suitable variable to use for financial counseling.

Forms processing involves primarily clerical duties. The level of service required is directly related to the number of financial aid applications. In addition, the number of financial aid applications stays proportionately the same in relation to total headcount enrollments. The study thus assumes that expenditures for forms processing vary directly with student headcount.

Administrative and clerical costs for financial aid administration were assumed to be fixed costs because they are not directly affected by the level of services required by the student body.

Costs for financial aid administration, separated into their fixed and variable components, are shown in Exhibit 6.5.

Records and Admissions. Both services of this activity are intensively involved with students. It was therefore decided to consider the expenditures of these two activities as varying with student headcount. Costs for administrative and clerical staffs were assumed to be fixed because, again, they are not directly affected by the level of services required by the student body.

Costs for records and admissions, separated into their fixed and variable components, are shown in Exhibit 6.6.

Calculation of Fixed and Variable Costs. Exhibits 6.7, 6.8, and 6.9 show how the fixed and variable costs were calculated for each student service. Exhibit 6.7 was developed by dividing the expenditures for each service by the weighted student headcount enrollments (Exhibit 6.2). Exhibit 6.8 was developed by multiplying the unit costs calculated in Exhibit 6.7 by the weighted factors of Exhibit 6.2 to estimate the effect of enrollment changes on student services. Exhibit 6.9 is a simple proof showing that the enrollment levels of 1977–78 multiplied by the calculated variable unit costs plus the fixed costs equals the expenditures for student services in 1977–78.

Step 5. Evaluate and Document the Policy Implications of the Study

Managers are generally aware that different students require different services, yet they are seldom asked to quantify those differences. An exercise such as this one requires close evaluation of each program area and students' requirements for various services.

The weighted factors and weighted headcount enrollment demonstrate the use of student services by various program areas. The assignment of costs and staffing levels to each of the service activities then creates a valuable tool to be used in making planning decisions. Weighted enrollments can be used to measure the impact of changes in enrollment on student services.

The value of this project to state policy and decision making lies in its focus on fixed and variable costs as a potential basis for allocating funds to institutions. Most funding formulas used currently distribute funds on the basis of full unit cost per full-time equivalent student. This approach assumes that all costs vary directly with the change in FTE students. Although it is generally acknowledged that this assumption is not true, little data or analysis has supported the use of fixed and variable costs. This study provides evidence that certain types of costs do not vary directly with the change in volume of FTE students but that they tend to remain constant within a relevant range. This study also shows that enrollments in different types of programs have a varying im-

pact on the service provided by certain programs and, as a result, on the behavior of costs in these programs. Although these preliminary results cannot be used in a funding formula, the concept and techniques used in this study could lead to a more equitable distribution of funds to institutions with changing enrollments. This approach is particularly important to institutions with declining enrollments or to those where the program enrollment mix is changing significantly.

The following observations can be made about the analysis.

1. **Expenditures for student services are heavily oriented toward counseling and advisement.** Of the $681,000 spent in 1977–78, $325,302 was for counseling and advisement (see Exhibit 6.10). Approximately one-half of that amount was for one behavioral sciences course. It is probably because of this strong investment in personal and career counseling that the college ranks in the upper quarter of all state two-year institutions for expenditures in student services.

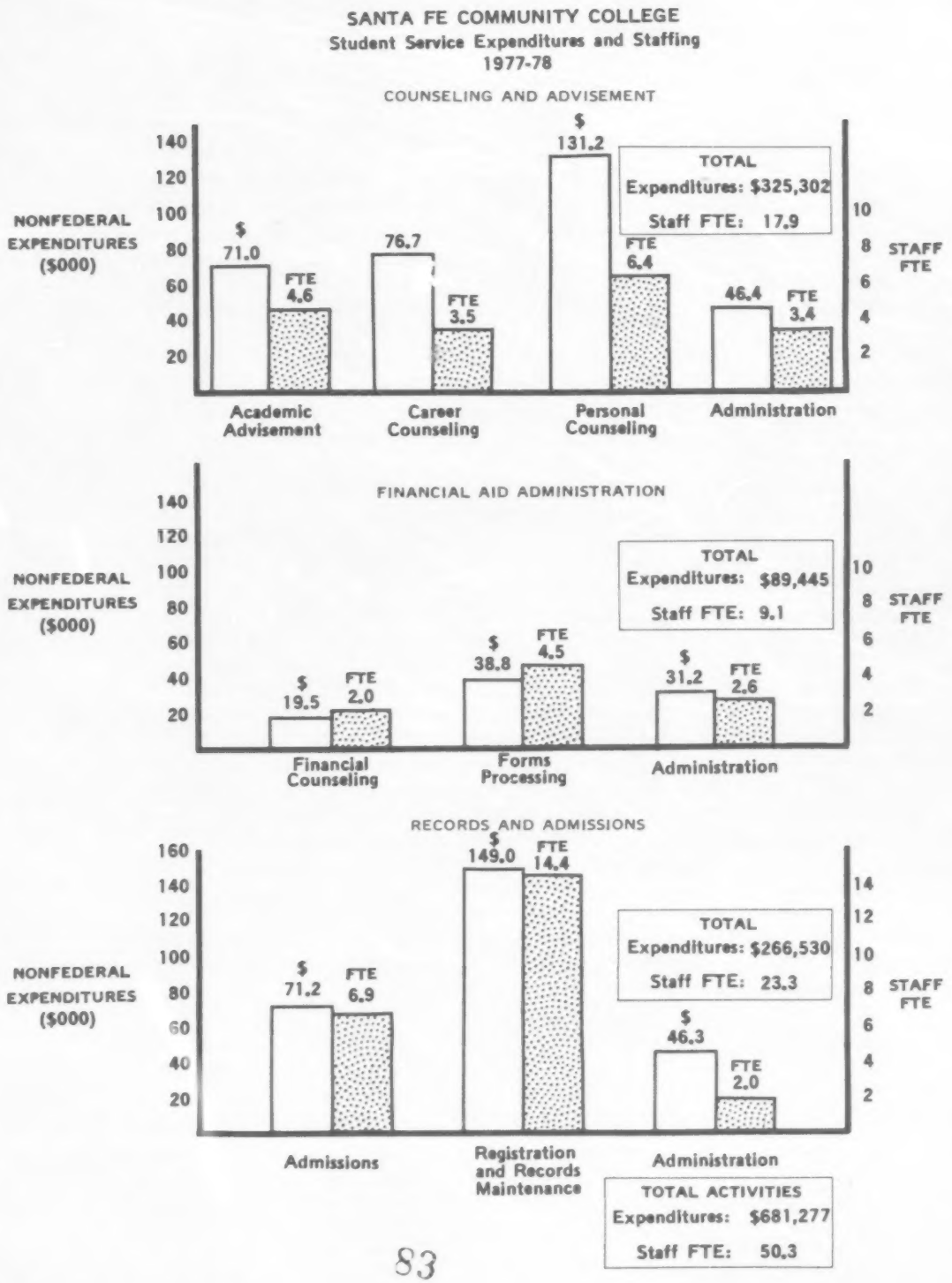
As would be expected, counseling and advisement also has the highest variable unit costs (see Exhibit 6.10). One implication of the high variable cost is that counseling and advisement will be more greatly affected by changes in enrollments than will financial aid administration or records and admissions.

2. **The A&P and credit occupational student programs rely more heavily on student services than do the other student programs.** The analysis shows that the A&P and credit occupational programs require all of the student services offered. In contrast, high school students require less personal counseling and fewer records and admissions services, and no student financial aid services. For the noncredit student programs, the contrast is even greater; the noncredit occupational program requires minimal career and personal counseling and records and admissions services, and no student financial aid. CIS program students require only a small amount of records and admissions services.

Exhibit 6.11 recaps the student services used by the various student programs in 1977–78. Using these observations, one can estimate the impact on student services caused by changes in enrollment in the various student programs. For example, the analysis suggests that an increase of 100 A&P students would have more than five times the impact on student service resources than would a similar increase in 100 noncredit occupational students. Based on 1977–78 data, Exhibit 6.11 illustrates that the variable unit cost varies from $83.52 per student to $5.99 per student.

3. **The state funding formula used to appropriate funds to community colleges should be based on student headcounts rather than student FTEs for the student service function.** It is evident that student service activities vary in relation to the absolute size of the student body and not by the cumulative full-time enrollment. Activities such as advisement, counseling, forms processing, admissions, and recordkeeping are essentially the same whether a student is full-time or part-time. The state funding formula should also take into account the type of student enrolled because each student program uses student services to a different degree.

Exhibit 6.1


SANTA FE COMMUNITY COLLEGE
Student Service Expenditures and Staffing
1977-78
COUNSELING AND ADVISEMENT
NONFEDERAL EXPENDITURES ($000)
STAFF FTE
$ 71.0
FTE 4.6
76.7
FTE 3.5
$ 131.2
FTE 6.4
46.4
FTE 3.4
TOTAL Expenditures: $325,302
Staff FTE: 17.9
Academic Advisement
Career Counseling
Personal Counseling
Administration
FINANCIAL AID ADMINISTRATION
NONFEDERAL EXPENDITURES ($000)
STAFF FTE
$ 19.5
FTE 2.0
$ 38.8
FTE 4.5
$ 31.2
FTE 2.6
TOTAL Expenditures: $89,445
Staff FTE: 9.1
Financial Counseling
Forms Processing
Administration
RECORDS AND ADMISSIONS
NONFEDERAL EXPENDITURES ($000)
STAFF FTE
$ 71.2
FTE 6.9
$ 149.0
FTE 14.4
$ 46.3
FTE 2.0
TOTAL Expenditures: $266,530
Staff FTE: 23.3
Admissions
Registration and Records Maintenance
Administration
TOTAL ACTIVITIES
Expenditures: $681,277
Staff FTE: 50.3

ANALYSIS OF STUDENT SERVICES COSTS
SANTA FE COMMUNITY COLLEGE
Calculation of Weighted Student Headcount

Student Headcount	Student Programs	Activities and Tasks: Counseling & Advisement — Academic Advisement	Counseling & Advisement — Career Counseling	Counseling & Advisement — Personal Counseling	Financial Aid Administration — Financial Counseling	Financial Aid Administration — Forms Processing	Records & Admissions — Admissions	Records & Admissions — Registration & Records Maintenance
	Credit							
3,878	A&P	1	1	1	1	1	1	1
2,130	Occupational	1	1	1	1	1	1	1
260	High School	1	0.7	0.7	-0-	-0-	0.5	0.5
	Noncredit							
1,827	Occupational	-0-	0.1	0.1	-0-	-0-	0.2	0.5
2,614	CIS	-0-	-0-	-0-	-0-	-0-	0.2	0.2
10,729	Total Weighted Student Headcount	6,288	6,387	6,387	6,008	6,008	7,036	7,501

Based on 1977-78 Student Headcount Fall Term Enrollments

The weighted factors are based on the determination that a student program directly uses or benefits from an activity and task and the extent to which the student program relies upon, requires, or uses the services of the activity or task. If there is no direct use or benefit, the weighted factor is 0. These weights are subject to change based on changes in administrative policies.

Exhibit 6.3

COSTS AND STAFFING FOR SELECTED STUDENT SERVICES
FISCAL YEAR 1977-78

(Nonfederal expenditures only)

Counseling and Advisement	**FTE**	**Expenditures**	**%**
Academic Advisement	4.6	$ 70,994	10.4
Career Counseling	3.5	76,730	11.3
Personal Counseling	6.4	131,181	19.3
Administration	3.4	46,397	6.8
Subtotal	17.9	$325,302	47.8
Financial Aid Administration			
Financial Counseling	2.0	19,464	2.9
Forms Processing	4.5	38,281	5.7
Administration	2.6	31,154	4.6
Subtotal	9.1	$ 89,445	13.2
Records and Admissions			
Admissions	6.9	71,193	10.4
Registration and Records Maintenance	14.4	149,042	21.9
Administration	2.0	46,295	6.8
Subtotal	23.3	$266,530	38.9
Total	50.3	$681,277	100.0

SANTA FE COMMUNITY COLLEGE
ANALYSIS OF SELECTED COSTS BY CATEGORY AND FUNCTION
FISCAL YEAR 1977-78

	Fixed		Variable								
	Administrative, Clerical, and Other		*Academic Advisement*		*Career Counseling*		*Personal Counseling*		*Total Headcount Expenditures*		
	FTE	$	FTE	$	FTE	$	FTE	$	FTE	Head-count	$
Professional Staff	.2	4,376	2.6	51,591	3.5	71,162	5.5	114,460	11.8		241,589
Support Staff	3.2	38,694	2.0	14,282			.9	7,141	6.1		60,117
Subtotal Personnel Costs	3.4	43,070	4.6	65,873	3.5	71,162	6.4	121,601	17.9	43	301,706
Operating Expense		2,471		4,222		4,591		7,899			19,455
Capital Outlay		584		899		977		1,681			4,141
Total Nonfederal Expenditures	3.4	46,397	4.6	70,994	3.5	76,730	6.4	131,181	17.9	43	325,302

Source: Based on worksheet prepared by J. Dougheny, Santa Fe Community College, March 15, 1979.

Exhibit 6.5

SANTA FE COMMUNITY COLLEGE
ANALYSIS OF SELECTED COSTS BY CATEGORY AND FUNCTION
FISCAL YEAR 1977-78

	Fixed		Variable						
	Administrative, Clerical, and Other		*Financial Counseling*		*Forms Processing*		*Total*		
	FTE	$	FTE	$	FTE	$	FTE	Head-count	$
Professional	1.0	15,219					1.0	1	15,219
Support Staff	1.6	11,400	2.0	14,250	4.5	31,351	8.0	13	57,001
Subtotal Personnel Costs	2.6	26,619	2.0	14,250	4.5	31,351	9.1	14	72,220
Operating Expense		4,419		5,081		7,285			16,785
Capital Outlay		116		133		191			440
Total Nonfederal Expenditures	2.6	31,154	2.0	19,464	4.5	38,827	9.1	14	89,445

Source: Based on worksheet prepared by J. Dougheny, Santa Fe Community College, March 15, 1979.

Exhibit 6.6

SANTA FE COMMUNITY COLLEGE
ANALYSIS OF SELECTED COSTS BY CATEGORY AND FUNCTION
FISCAL YEAR 1977-78

	Fixed		Variable						
	Administrative, Clerical, and Other		*Admissions*		*Registration & Records Maintenance*		*Total*		
	FTE	$	FTE	$	FTE	$	FTE	Head-count	$
Professional	2.0	42,462					2.0	2	42,462
Support Staff			6.9	60,794	14.4	125,691	21.3	46	186,485
Subtotal Personnel Costs	2.0	42,462	6.9	60,794	14.4	125,691	23.3	48	228,947
Operating Expense		3,564		9,668		21,710			34,942
Capital Outlay		269		731		1,641			2,641
Total Nonfederal Expenditures	2.0	46,295	6.9	71,193	14.4	149,042	23.3	48	266,530

Source: Based on worksheet prepared by J. Dougheny, Santa Fe Community College, March 15, 1979.

ANALYSIS OF STUDENT SERVICES COSTS
SANTA FE COMMUNITY COLLEGE
Fixed and Variable Costs by Student Service Task
Fiscal Year 1977-78

Variable	Counseling and Advisement			Financial Aid Administration		Records and Admissions		Variable Cost per Student Headcount
	Academic Advising	Career Counseling	Personal Counseling	Financial Counseling	Form Processing	Admissions	Registration & Records Maintenance	
Personnel								
Administration	8.20	11.14	17.92					37.26
Professional	2.28	—	1.12	2.37	5.22	8.64	16.76	36.39
Subtotal	10.48	11.14	19.04	2.37	5.22	8.64	16.76	73.65
Operating Expense	.67	.72	1.24	.85	1.21	1.37	2.89	8.95
Capital Outlay	.14	.15	.26	.02	.03	.10	.22	.92
Total	11.29	12.01	20.54	3.24	6.46	10.11	19.87	83.52
Weighted Student Headcount	6,288	6,387	6,387	6,008	6,008	7,036	7,501	

Fixed	Counseling & Advisement	Financial Aid Administration	Records and Admissions	Total Fixed Costs
Personnel				
Professional Staff	4,376	15,219	42,462	62,057
Support Staff	38,694	11,400		50,094
Subtotal	$43,070	$26,619	$42,462	112,151
Operating Expense	2,743	4,419	3,564	10,726
Capital Outlay	584	116	269	969
Total	$46,397	$31,154	$46,295	$123,846

Exhibit 6.7

Exhibit 6.8

ANALYSIS OF STUDENT SERVICES COSTS
SANTA FE COMMUNITY COLLEGE
Calculation of Variable Cost by Student Program

Student Programs	Activities and Tasks: Counseling and Advisement — Academic Advisement WT[a]		Career Counseling WT[a]		Personal Counseling WT[a]		Financial Aid Administration — Financial Counseling WT[a]		Form Processing WT[a]		Records and Admissions — Admissions WT[a]		Registration & Records Maintenance WT[a]		*Variable Cost by Student Program*[b]
Credit:															
A&P	1	11.29	1	12.01	1	20.54	1	3.24	1	6.46	1	10.11	1	19.87	83.52
Occupational	1	11.29	1	12.01	1	20.54	1	3.24	1	6.46	1	10.11	1	19.87	83.52
High School	1	11.29	.7	8.41	.7	14.38	-0-	-0-	-0-	-0-	.5	5.06	.2	3.97	43.11
Noncredit:															
Occupational	-0-	-0-	.1	1.20	.1	2.05	-0-	-0-	-0-	-0-	.2	2.02	.5	9.94	15.21
CIS	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	.2	2.02	.2	3.97	5.99
Variable Cost per Service[c]	$11.29		$12.01		$20.54		$3.24		$6.46		$10.11		$19.87		

Notes:
[a]This is the factor used to determine the extent each student program uses the services of each task. See Exhibit 6.2.
[b]This is the variable cost to use when estimating changes in expenditures resulting from changes in enrollment. For example, an increase of 100 A&P students means an increase of $8,352 is required in expenditures for student services, while an increase of 100 CIS students requires only an increase of $599 in expenditures for student services.
[c]This calculation uses the weighted student headcount as the denominator.

Exhibit 6.9

ANALYSIS OF STUDENT SERVICES COSTS
SANTA FE COMMUNITY COLLEGE
Distribution of Student Service Costs by Student Program

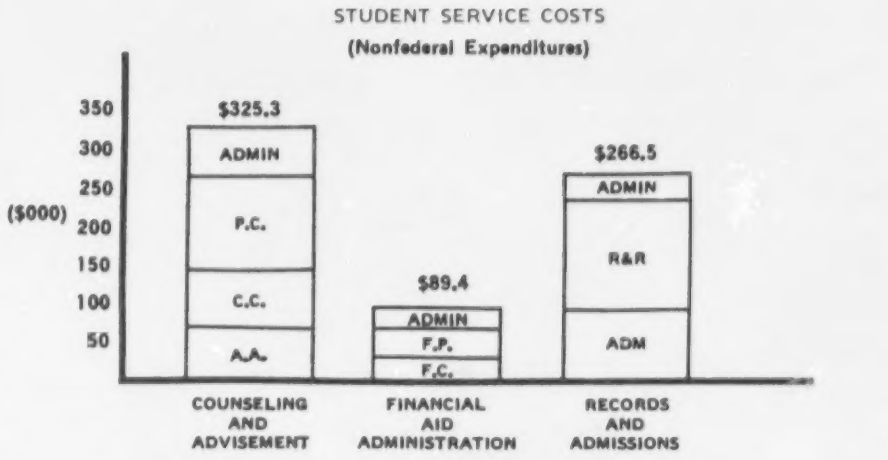
	Student Headcount Enrollment Fall 1977-78	*Variable Cost by Student Program*[a]	*Total Variable Cost*[b]
Student Programs			
Credit:			
A&P	3,878	$83.52	$323,890
Occupational	2,130	83.52	177,898
High School	280	43.11	12,071
Noncredit:			
Occupational	1,827	15.21	27,789
CIS	2,614	5.99	15,658
	10,729	Total Variable Cost	557,306
		Total Fixed Cost	123,846
		Total Student Service Cost	$681,152

Notes:

[a]See Exhibit 6.7 for calculation.

[b]The variable costs shown in this column vary proportionately with enrollment. The A&P and credit occupational programs account for virtually all (90%) of student services although they represent only 56% of the headcount enrollment.

Exhibit 6.10



ADMIN = Administrative
P.C. = Personal Counseling
C.C. = Career Counseling
A.A. = Academic Advisement
F.P. = Forms Processing
F.C. = Financial Counseling
R&R = Registration & Records Maintenance
ADM = Admissions

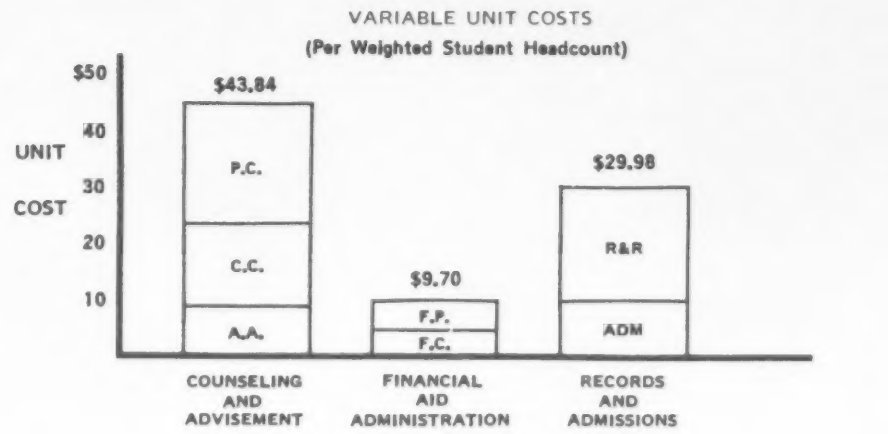
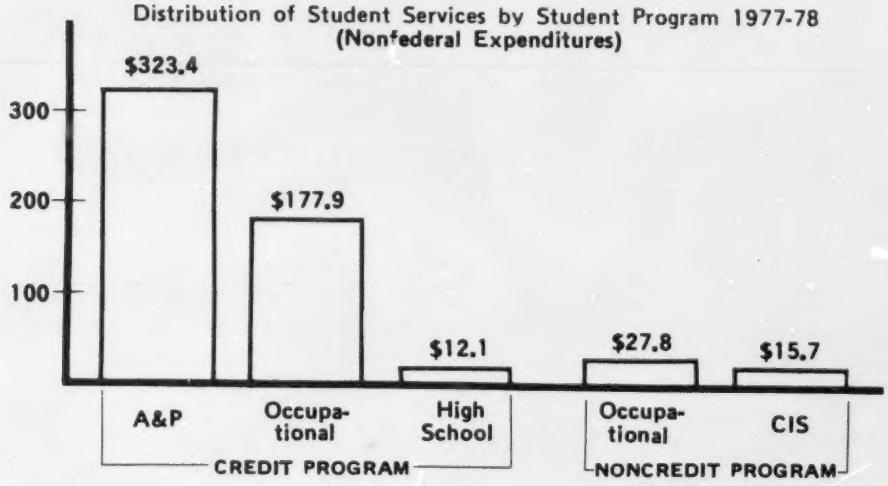
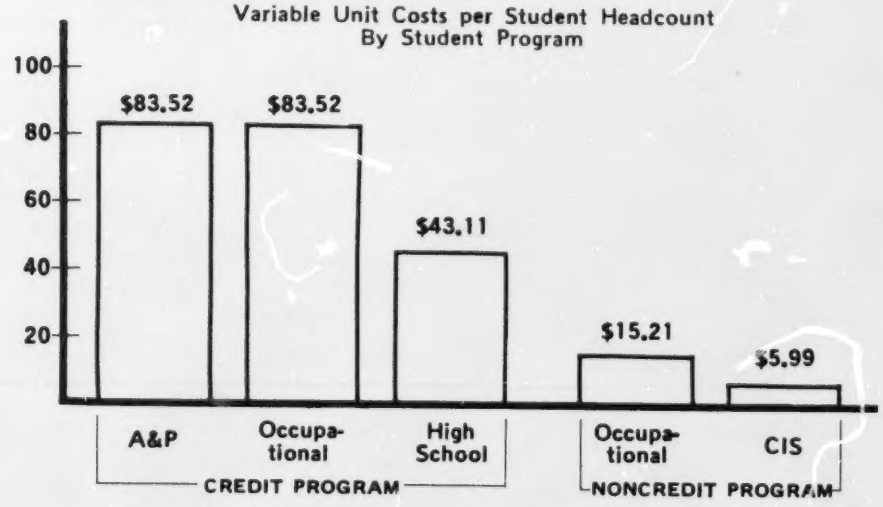


Exhibit 6.11

SANTA FE COMMUNITY COLLEGE





seven • wisconsin system: library services

The University of Wisconsin System includes 13 universities and 14 two-year centers, which enrolled a total of 147,934 degree-credit students in September 1978. The Wisconsin System also includes a statewide extension service used by more than 2.5 million people each year. Several institutions in the System have experienced declining enrollment with the concomitant planning pressures and program adjustments likely to be faced by all institutions in the 1980s. The Wisconsin System's primary concern has been to maintain essential university programs and services, although at an adjusted level.

The funding formula in Wisconsin has been modified several times during the last decade, progressing from a formula based on FTE students by enrollment level to a formula based on student credit hours, which attempted to reflect average costs by mix of enrollment level and discipline. In the 1977–79 biennium, the state formula underwent major revision when, for the first time, the concept of fixed and variable costs was recognized, and funding for enrollment changes was based only on variable costs. The proportion of total costs classified as fixed at that time was low and somewhat arbitrary, because little empirical data were available.

The Wisconsin System planning study on fixed and variable costing was initiated because of a concern that the current state funding formula does not adequately reflect actual cost behavior, particularly during a time of declining enrollments. An institution's viability may be greatly diminished if the funding level drops at a rate corresponding to that of enrollments, especially for smaller institutions, where such a reduction may place services and programs at a level below that deemed essential for the existence of the university. A special task force assigned to study the probable consequences of further budget reductions at the System's smallest four-year campus concluded that fiscal resources could not be further reduced without severely compromising the array and quality of programs provided.

The need to reexamine the adequacy of the present assumptions, criteria, and procedures by which the Wisconsin System has managed its fiscal relationship with state government was further reinforced by a request from the governor to review the current formula and to develop, if necessary, recommendations for a more appropriate funding mechanism for the System. The

concern again was to make the state's financial support more responsive to actual cost behavior in a decade of declining enrollments.

In response to this need, the Wisconsin System conducted a study of fixed and variable costs to develop a preliminary determination of the proportion of costs that are fixed within each university functional area and a measure of how the residual variable costs vary with volume factors such as enrollments. Recommendations on the proportion of fixed and variable costs, by function, as well as on probable cost behavior patterns will be used to develop modifications in or alternatives to the current funding formula. The funding sources were limited to the state appropriation and student academic fees.

The Wisconsin System study of fixed and variable costs addressed the functional areas of instruction, academic support, and student services for all institutions. Participation in the NACUBO/NCHEMS cost behavior analysis was limited to the academic library (part of the academic support function) for four nondoctoral institutions within the System. These institutions all offer varied baccalaureate and selected master's degree programs, and one offers the Education Specialist degree.

The purposes of the study were to determine the proportion of fixed costs within academic libraries and a measure of how residual variable costs vary with factors external to the library. The study was not intended to be an institutional management tool but rather to indicate total System resource needs for library services under varying enrollment conditions. The study's specific objectives were:

1. To develop a methodology for determining the irreducible program costs (fixed component of costs) for the library function.
2. To identify the factors that affect variable costs within libraries.
3. To establish the base of information necessary to estimate the proportion of fixed costs, by institution, and determine the relationship between the residual variable costs and the factor(s) that affect those costs.
4. To consult with institutional personnel in:
   a. The identification of criteria for determining fixed and variable costs within libraries.
   b. The development of methodology for estimating fixed and variable costs.
   c. The application of the methodology within specific institutions.
5. To recommend modifications in the state funding formula to reflect more accurately fixed costs and inequities of scale during a period of stable or declining enrollments.

Table 5 shows the enrollments at the four institutions involved in this study.

Table 5

Fall 1978 Data	UW-Institution			
Credit Enrollment	(A)	(B)	(C)	(D)
Headcount	10,494	3,715	10,020	4,630
FTE	9,835	2,775	8,480	4,517
Part-Time Students	1,449	1,536	3,187	604
Legal Faculty (FTE)	470.96	156.88	499.95	238.51

Library Services

Library services include public services and technical services, which are coordinated by an administrative function. The administrative function is responsible for coordinating all library activities, for managing the internal operations of the library, and for developing program and fiscal plans. The public services function is responsible for facilitating access to the library collection for students, faculty, staff, and others. Several activities are essential components of public services. They include reference and information, orientation and instruction, circulation, and interinstitutional exchanges and loans. The technical services function is responsible for acquiring, processing, and maintaining the library collection. This function includes the development of collections and materials acquisition, materials organization and control, and materials preparation.

Table 6 shows the number of FTE staff members and the budget for each of the four institutions in the study, based on 1978–79 data.

Table 6

	Institution			
	A	B	C	D
FTE Staff				
Technical Services	11.3	12.2	16.1	15.0
Public Services	10.4	7.9	10.5	17.5
Administration	4.0	3.9	2.0	3.0
Total State/Student Fee Budget	$548,743	$614,404	$883,760	$1,028,488

Step 1. Determine Policy Questions and Identify the Management Level Served by the Study

The cost behavior analysis of the four libraries was done as part of a larger effort to study the cost behavior of all instruction-related functions other than physical plant operation. The broad purpose of the comprehensive study was to provide data to the board of regents, the president of the System, institutional chancellors, and the state government for use in determining the level of fiscal support necessary to maintain essential university programs and services during the declining enrollment of the 1980s.

The primary concern was to better understand the resources required for the academic libraries at the four institutions if they are to continue providing effective academic support services to the instructional programs and to students, faculty, and staff during a period of declining enrollments and reduced resources. The second concern was to identify the major factors affecting the needed levels of library services and how changes in these factors affect changes in resource requirements. The third concern was to provide empirical data to support revisions in the state funding formula to insure adequate resources to maintain effective libraries.

A steering committee chaired by the senior vice president of the Wisconsin System had overall responsibility for the study. A study group reporting to the

steering committee was charged with developing preliminary determinations of the proportions of fixed costs within each service area and measures of how the residual variable costs vary with policy and volume factors. In addition, a library advisory group developed a mechanism representing the behavior of the costs of maintaining programs and services as enrollments change. The analysis was thus restricted to the relationships between changes in enrollment levels or programs and needed levels of library services and, thus, costs. The basic decision for all studies was to neutralize these factors as much as possible by assuming the continuation of existing services at current levels. This assumption was facilitated by using comparative data for the four institutions from one base year rather than by using historical data.

Step 2. For Each Function Under Study, Identify the Activities, Activity Measures, and Factors That Affect Costs

The basic considerations for selecting activity components were to combine types of costs and services with similar cost behavior patterns and to maintain consistency with national taxonomies that have been developed. (Actual campus organizational structures will vary from this activity distribution.) The following broad functional components were used (see Exhibit 7.1 for details): (1) public services, (2) technical services, and (3) administration.

After selecting and defining activity areas, the library advisory committee addressed the issue of which volume factors affect the level of activity (workload) required in each of the broad functional areas. It was determined that students and faculty have the major influence on activity levels for public services. FTE students, weighted by enrollment level, became the volume factor for public services as library use appears to increase with more advanced student levels and larger student course loads. Fall 1978 enrollments were used for each institution.

As Exhibit 7.1 indicates, student numbers do not significantly affect the level of activity or workload in technical services; rather the workload is affected by the level of acquisitions. Technical service activities are closely related to acquiring, processing, and handling collection materials. Because the development of collections is tied to direct support of the institution's programming, the necessary level of acquisitions is generated by the institution's range and levels of academic programs and courses.

Step 3. Determine Current Levels of Service For Each Activity and Assign Costs to Each Activity

As budget data on library activities collected systemwide are limited to positions and dollars by organizational unit, most data needed by activity for the study were compiled by each institution in response to a questionnaire. The library advisory group determined that the following data needed to be collected, by institution:

1. State/student fee budgeted staff FTE positions by activity area
   a. Unclassified
   b. Classified

c. Part-time
(1) Limited-term
(2) Student

2. Expenditure data (state/student fee) on material acquisitions, by type of material; other capital; and supplies and services
3. Number of library holdings and number of acquisitions for base year, by type of material
4. Data on activity levels within public services
a. Service hours
b. Circulations
c. Interlibrary loan transactions
d. Reference hours

In addition, System data were provided on average staff salaries and program offerings by level.

Two major assumptions were made in this study that are basic to the determination of fixed costs: (1) that the current mission, program array, and course offerings of each institution are used, and (2) that the current range and level of library services and activities are used. Activities within the library were defined as influenced by programs and courses (technical services) or by students and faculty (public services). That portion of costs not influenced by volume factors but essential for the existence of the service was defined as fixed.

In the public service area, the library advisory group, using staffing levels, enrollments, and activity levels for each institution and an analysis of the range of jobs within each activity (see Exhibit 7.2), determined that a staffing level of 3.7 FTE should be considered fixed. This level of staffing assumes a library open 90 hours per week with reference staffing for 40 hours per week.

As technical services staffing was judged to relate to acquisitions and, thus, to the collection level needed to support the program array of the individual institution, the fixed level of acquisitions had to be determined first. The standards developed by the Association of College and Research Libraries providing volume allowances per academic program were used to determine the base collection. A basic collection of 85,000 volumes plus 350 volumes per undergraduate degree program and 6,000 volumes per master's/specialist degree program is considered to be the library collection necessary to support the academic programs of each institution (see Exhibit 7.3).

In addition, a rate of 10% per year for replacement and acquisition was used to set the level of annual acquisitions in volumes necessary to maintain the basic collection. This level was defined as the fixed level of acquisitions. The number of volumes times average cost per volume divided by total current acquisition dollars became the fixed portion of the institution's acquisitions budget. Dollars currently spent on acquisitions in excess of that level were defined as variable and were identified as varying with changes in student FTE, weighted by level.

After analyzing job responsibilities within technical services, the library advisory group concluded that 6.0 FTE staff were required as a base level (see Exhibit 7.2). This level of staffing is expected to handle the processing and maintenance functions for a library collection serving a program array of 30 undergraduate programs. However, because the program arrays of the institu-

tions in the study are broader, the fixed level of technical service staffing had to reflect differing and higher requirements.

To determine the fixed technical services staffing level at each institution, a regression analysis was used to determine the relationship between FTE staff (from actual staffing patterns) and level of actual acquisitions (in volume equivalents). Once the linear relationship was calculated, the resulting equation was used to project the appropriate staffing levels necessary to handle the fixed level of acquisitions calculated earlier to support the institution's program array. Exhibit 7.4 contains the resulting equation, graph, and projected staffing levels. Thus, the fixed level of staffing for technical services was set at 6.0 FTE plus the additional FTE generated by the regression equation to handle the fixed level of acquisitions.

The library advisory group felt that two FTEs should be considered a fixed level of staffing for library administration. The fixed level of staffing (in FTEs) for libraries was the total of fixed staff in public services, technical services, and administration. (It is important to note here that fixed staffing levels were based on judgments of workload generated by required tasks and not on the basis of existing staffing configurations or commitments.) Average salary dollars per FTE, by institution, were multiplied by the total fixed library FTE at the institution and divided by total library salary dollars to yield the proportion of the library salary budget that was fixed, by institution. "Supplies and services" and "other capital" dollars (material aquisition dollars having already been removed and calculated above) were prorated across fixed and variable costs in proportion to the number of total FTE staff in each cost category.

Each institution's proportion of fixed costs for library services is thus the sum of fixed salary dollars, fixed acquisition dollars, and fixed supplies and services and other capital dollars divided by the total library budget.

Step 4. Determine the Behavior of Costs For Each Activity

A linear regression analysis was used to develop the cost behavior patterns of the residual variable costs (after fixed costs have been identified and removed). The incremental demands for public service staff beyond the 3.7 fixed staff were determined by relating total FTE staff to total weighted FTE students. (Weighted FTE students were identified earlier as the appropriate volume factor for public services staffing.) The resulting equation can be used to project staffing needs for public services at varying enrollment levels (see Exhibit 7.5).

For technical services, the relationship between staff FTE and volume acquisitions, used to determine fixed staff levels, was also used to project variable cost behavior. The staff FTE required to process acquisitions beyond the basic level to replace and acquire collections are considered to be variable costs but bear the same relationship to acquisitions as do the fixed staffing levels calculated earlier (see Exhibit 7.4).

Step 5. Evaluate and Document the Policy Implications of the Study

The methodology used to study fixed and variable costs at the four institutions will be applied to academic libraries at all 27 campuses of the Wisconsin System. The final report in the section on libraries will include the following

types of recommendations to the steering committee, the president, board of regents, and the state government:

1. The proportion of total current state dollars for System libraries that must continue to be provided if each academic library in the System is to maintain a collection necessary to support its programs and a basic level of staffing necessary to process materials and to maintain user access to the collection.

2. The use of weighted student FTE to generate incremental changes in public services staffing levels and the use of annual acquisitions and replacements to generate incremental changes in technical services staffing levels.

3. The use of academic programs by level as the basis for generating the volumes that are required for a basic library collection necessary to support these programs.

4. The formulary representation of the relationship between public services staffing and weighted FTE students and the relationship between technical services staffing and volumes of acquisitions so that the appropriate level of library staffing can be projected from changes in enrollment levels or program array.

5. The use of the analyses of fixed costs and variable cost behavior to develop modifications in the state funding formula so that essential levels of academic library collections and services can be maintained during the 1980s.

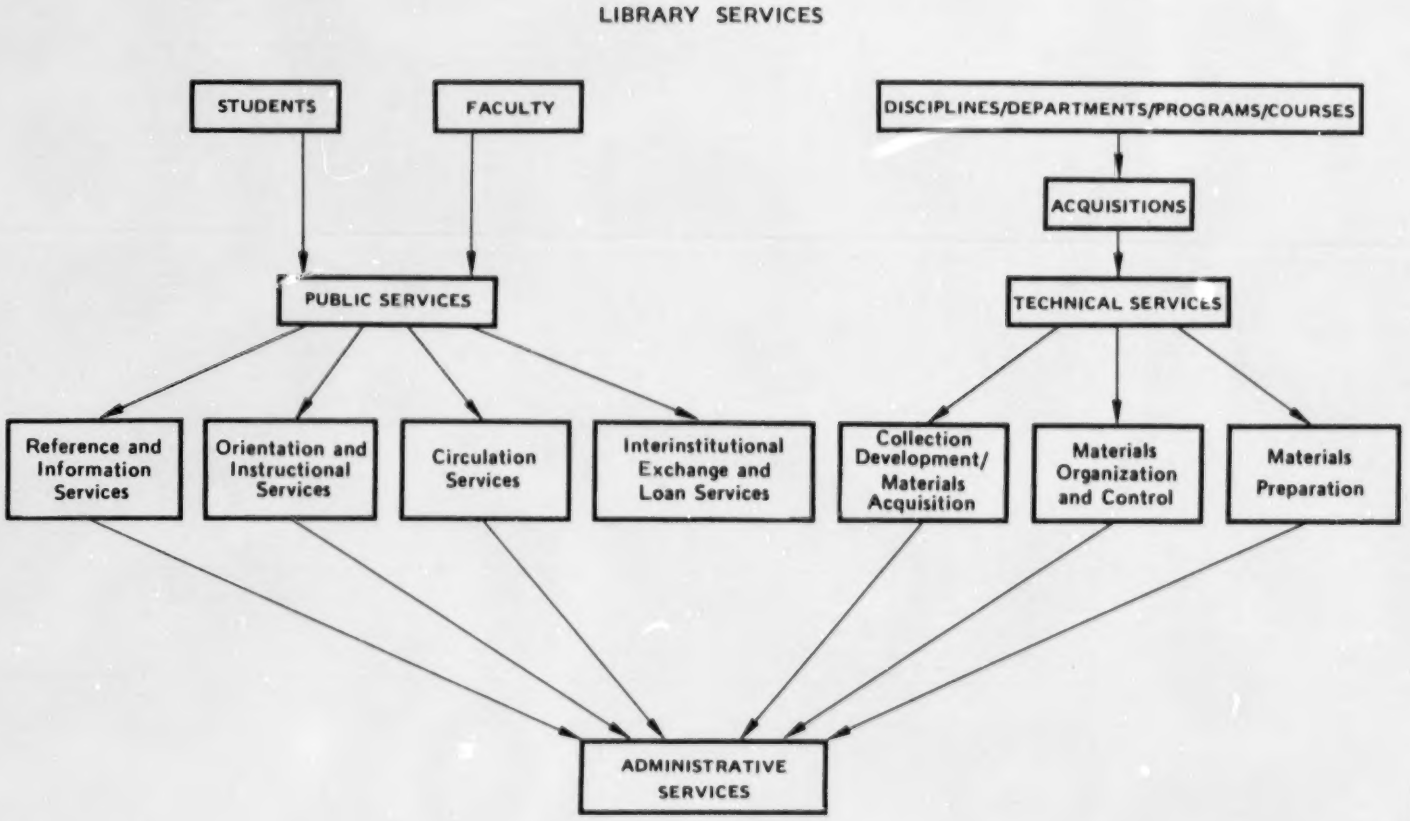

LIBRARY SERVICES
STUDENTS
FACULTY
DISCIPLINES/DEPARTMENTS/PROGRAMS/COURSES
ACQUISITIONS
PUBLIC SERVICES
TECHNICAL SERVICES
Reference and Information Services
Orientation and Instructional Services
Circulation Services
Interinstitutional Exchange and Loan Services
Collection Development/ Materials Acquisition
Materials Organization and Control
Materials Preparation
ADMINISTRATIVE SERVICES

Exhibit 7.1

Exhibit 7.2

Analysis of Responsibilities in the Determination of Fixed Levels of Positions

Public Services. To have services available at acceptable levels of quality regardless of enrollment (e.g., regular operating hours, efficient circulation system, adequate working relationship with other libraries, and effective information services), 3.7 librarians are considered necessary. The need for a fixed level of public service staffing is directly tied to the hours the library is open. The fact that demand is somewhat predictable allows the opportunity to occasionally assign staff to tasks removed from their primary responsibility; for example, the reference librarian can help with circulation. This interchange of jobs during the periods of lower demand allows fewer staff to provide reasonable services. However, public service areas are very sensitive to demand, and any increase in use is quickly felt.

Technical Services. To acquire, process, and maintain a basic collection serving a core program array of 30 undergraduate programs requires 6.0 FTE staff. Responsibilities assigned to technical services include: (1) developing and selecting collections; (2) verifying selection requests to determine whether the item is new to the library and whether the order information is correct; (3) processing necessary purchasing and accounting information; (4) receiving ordered materials to determine the correctness of the order and the physical condition of the materials; (5) organizing the materials by providing bibliographic access through the library catalog; (6) preparing the materials for public use; and (7) checking in periodical subscriptions.

Administration. The responsibilities associated with administrative functions will require at least 2.0 FTE staff, with the prospect that a decline in enrollments and budgets will have an inverse impact on administrative workload. The director of the library is expected to staff and organize the library, coordinate library resources and services with instructional and research activities, develop and control the library operating budget, and evaluate present performance and future needs.

Exhibit 7.3

Basic Library Collection, By Institution

Institution	Base Collection	# Undergrad. Degree Prog. x 360 Vol.		# MastiSpec. Degree Prog. x 6,000 Vol.		Total Volumes
A	85,000	35	12,250	1	6,000	103,250
B	85,000	52	18,200	5	30,000	133,200
C	85,000	47	16,450	18	108,000	209,450
D	85,000	50	17,500	18	108,000	210,500

Exhibit 7.4

TECHNICAL SERVICES

Fixed Level of Staffing

Institution	*Base +*	*Base Acquisitions Related* =*	*Total*	*Current Acquisitions (Vol. equiv.)*	*Current FTE Staff*	*% Fixed Staff*
A	6.0	3.6	9.6	17,655	11.3	85.0
B	6.0	4.7	10.7	20,499	12.23	87.4
C	6.0	7.4	13.4	30,181	16.05	83.5
D	6.0	3.4	9.4	16,676	15.0	89.3

*Base acquisitions-related fixed staffing levels are generated by the equation: Y = 6.0 + .000351235 X, where Y is the calculated staffing level related to acquisitions and X is the fixed level of acquisitions. The core staffing of 6.0 FTE is considered adequate to handle the processing and maintenance functions for a library collection serving a program array of 30 undergraduate programs. Calculations of base acquisitions for the institution are delineated in Exhibit 7.2.

Variable level of staffing is generated by the same equation using current level of acquisitions.

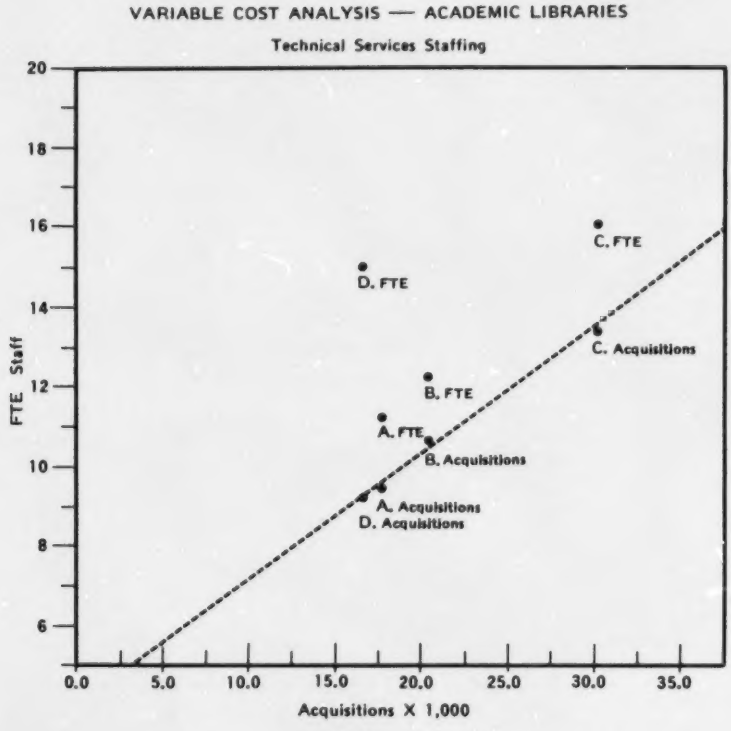
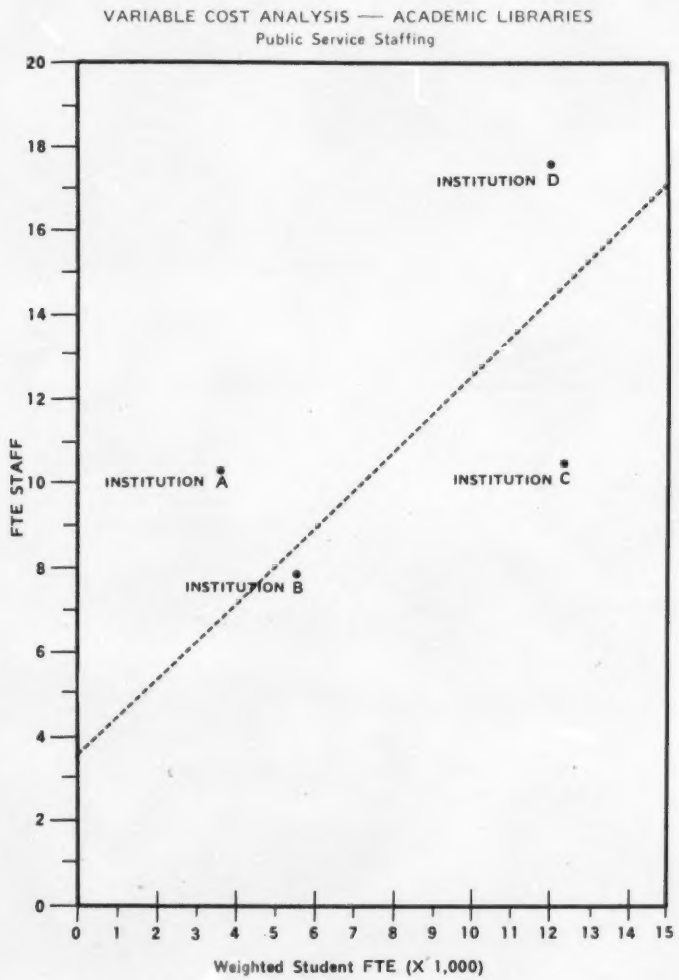


Exhibit 7.5

PUBLIC SERVICES

Institution	*Fixed Level of Staff (FTE)*	*Current Staffing (FTE)*	*Weighted Student FTE*	*Percent Fixed Staff*
A	3.7	10.4	3,680	35.6
B	3.7	7.91	5,636	46.8
C	3.7	10.45	12,340	35.4
D	3.7	17.5	12,026	21.1

Variable level of staffing is generated by the equation: Y = 3.7 + .00086975781X, where Y is the variable staffing FTE and X is the weighted student FTE.



eight • observations & conclusions

The information on cost behavior that was produced at each of the institutions influenced policy decisions to different degrees. The cost behavior analysis of libraries in the Wisconsin System could directly and significantly affect the state's funding formula for libraries, while the identification of faculty utilization rates was only one of many factors at Drake that influenced policies for program curricula and recruiting.

Regardless of the immediate impact that cost behavior analysis had on these decisions, all of the cost behavior analyses provided a method of examining the long-term costs of various functions. That operations and maintenance costs for the physical plant were examined in relation to types of space and levels of service is significant when compared to the traditional use of costs per average square foot. It is also important that costs of student services be determined relative to headcount enrollments in various academic programs.

All too often, analysts and other technical experts develop complex analyses and allocation algorithms to such a level of detail that policy makers such as presidents, governing boards, and responsible elected officials substantially discount or do not understand the usefulness of the cost information. Many cost studies and much cost information do not apply directly to issues decision makers are studying. The effectiveness and long-term usefulness of cost behavior analysis lie in including decision makers in the development of the study.

The initial participation of decision makers is essential to cost behavior analysis because these decision makers identify and limit the study to those factors that significantly affect cost. Once factors are weighted according to the impact each has on costs, they can be periodically updated to adjust relative weights or modified to include other factors.

Cost behavior analysis has many applications for a broad range of management issues: planning, pricing, funding, and tradeoff analyses.

1. **Planning.** Cost behavior analysis is useful to estimate or forecast how changes in enrollment levels, student preferences, and governmental regulatory requirements will affect an institution's revenues and expenditures.

2. **Pricing.** Cost behavior analysis is useful for establishing rates for dormitory and food services and for setting price mechanisms for internal transfers such as computing, printing, and maintenance.

3. **Funding Formula.** The Wisconsin System case study illustrates how cost behavior analysis can assist in determining governmental appropriations.

Similar analyses can be undertaken for other functions—for example, instruction, public service, or student services.

4. **Tradeoff Analyses.** The Denison, Santa Fe, and Wisconsin System case studies illustrate ways in which analysis can assist in determining the impact of various levels of service on operations and maintenance, student services, and libraries, respectively. Similar studies can be done for other areas such as a computer center, a print shop, athletics, fund raising, and alumni relations.

Caveats Regarding Cost Behavior Analysis

Cost behavior analysis requires good supporting data and operating systems. A major requirement of the case studies was the need for a substantial amount of supporting data, which were found in solid, well established central operating systems such as accounting, payroll, registration, space, faculty activity reports, and budgeting. A second source of data was the decentralized departmental records maintained by the librarians, physical plant manager, and student services director. The central operating systems provided the raw data that were used in the analyses, while the decentralized records of the individual departments were useful in establishing the underlying assumptions and developing the cost relationships used in the study.

As a prerequisite for undertaking similar studies, institutional managers should examine their basic support and operating systems. If the basic records systems are inadequate, the institution will probably be better served by improving them than by undertaking complex cost studies that are based on inadequate data.

Highlights of the Case Studies

Denison University. A major feature of the Denison study is the method used to assign O&M service levels to particular kinds of rooms. This analytic approach allows for the systemwide evaluation of how services (for example, cleaning, heating, and maintenance) vary by type of room. Another significant feature of the study is its use of data from a number of institutional sources. The space inventory data originated in the planning office and the expenditure records in the accounting office, and the O&M service information came from the physical plant director. The basic data to be analyzed were found in central university offices, while the operations manager kept the data used to develop the assumptions regarding the behavior of costs. Coordinating these sources of data into meaningful information that managers can use is an important contribution of the study. The third major feature of the study is its simplicity and ease of use. The Denison physical plant director now has available a simple analytic tool that shows him how expenses for operations and maintenance will be affected by changes in factors such as service levels and square footage.

Drake University. The Drake case study takes a significant step forward in analyzing the use of the faculty resource. The development of a formula that shows classroom utilization is an important feature of the study. Refining the formula can lead to better use of classroom space, the potential consolidation of class sections, and improvements in class scheduling. From another perspective, the Drake case is also a good example of the problems inherent in using massive amounts of data. Difficulties were experienced in (1) maintaining con-

sistency of data over the eight semesters, (2) dealing effectively with such detailed data, and (3) developing broad assumptions that would apply to all facets of the instructional process.

Santa Fe Community College. The Santa Fe case study is useful for its validation of the requirements of different kinds of students for varying levels of student services. The analytic framework, which groups students into categories based on the level of student services they use, is a concept that has broad application to other colleges and universities.

Another interesting feature of the Santa Fe case study, which it shares with Denison, is the use of informed judgment as well as quantitative historical records for determining service levels and service utilization. This determination is based on the judgment and experience of Santa Fe officials rather than on statistical data gathered by the institution. In both instances, quantitative data were not available, were inconsistent, or were inadequate. In addition, the results of the analyses depend more on the general relationships developed than on specific values assigned to each weighting factor. Another feature shared with Denison is the use of numerous sources of information. Basic student and expenditure information came from the registrar and accounting systems, but the development of the weighted factors came from the student services offices.

University of Wisconsin System. The Wisconsin System case study is significant because the library study was a component of a much larger effort to develop a formula to appropriate state revenues. It is the intention that the fixed and variable cost function developed for the Wisconsin System libraries will be integrated into the total institutional funding formula.

Another significant feature of the Wisconsin System study is the method used for dividing library services into those that are affected by student enrollments and those that are affected primarily by acquisitions. This distinction allowed for the development of a systematic method of determining ways that library appropriations can be reduced as the result of declining enrollments and still sustain the required level of acquisition. The Wisconsin System case study also illustrates how personnel within the service unit, in this case libraries, can be a valuable resource to the study. The Wisconsin System librarians were instrumental in identifying reasonable levels of fixed costs necessary to maintain a university library.

Future Courses of Action

1. **Further develop the cost behavior analysis process.** A logical extension of the case studies is to develop an analytic process that estimates how enrollments and other factors affect an institution's *total* operations. The analytic model would help institutional managers to better understand costs and revenues and be able to make more informed decisions.

2. **Document other cost behavior analyses.** Further examples similar to the four case studies should be developed. As more studies are documented, college and university analysts will be able to better adapt the costing process to their own situations.

3. **Develop a cost behavior analysis process for state planning.** The focus of the four case studies is on the college or university. A similar type of analytic process can be developed that reflects the resources allocated by the state to higher education.

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